THE CLASS BOOK OF ANATOMY,

EXPLANATORY OF THE FIRST PRINCIPLES

OF

HUMAN ORGANIZATION,

AS

THE BASIS OF PHYSICAL EDUCATION.

DESIGNED FOR SCHOOLS AND FAMILIES.

WITH NUMEROUS ILLUSTRATIONS, AND A VOCABULARY OF TECHNICAL TERMS.

By JEROME V. C. SMITH, M. D.,

EDITOR OF THE BOSTON MED. AND SURG. JOURNAL, AND FORMERLY PROF. OF GEN. ANAT. AND PHYSIOL. IN BERKSHIRE MED. INSTITUTION.

—— "I am fearfully and wonderfully made."

FOURTH, IMPROVED STEREOTYPE EDITION.

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PREFACE

TO THE FIRST EDITION.

SHOULD the following work, in the hands of public instructers, be instrumental in explaining to the young a general knowledge of their own curious organization, it may lead to the adoption of such habits in early life, as will insure health in youth, and intellectual vigor in age.

The questions interspersed through the book are far from embracing all the subjects adverted to in the several natural divisions of the text: they are merely examples of the best mode of conducting the study, leaving it entirely with the teacher to select such parts for recitation as he may conceive most advisable.

Technical words have not been wholly avoided; such as have been retained are for the *master*, to aid him in acquiring a more minute and exact knowledge of the science, that he may be the better prepared to assist those who are intrusted to his care.

If the volume should meet the approbation of those who are devoted to the best interests of mankind, it will not have been written in vain.

J. V. C. SMITH.

QUARANTINE GROUND,
Port of Boston.

Jan. 1834.

PREFACE

TO THE SECOND EDITION.

A STORY is related of a painter, who suspended a picture in the market-place of the city where he resided, on which his utmost skill had been exerted. By the side of it was a brush and colors, with a request that all good judges of the divine art of painting would judiciously alter any defects they might discover, which had escaped his own eye.

Nothing could have been more gratifying to the innate vanity of such as considered themselves qualified to decide upon the value or demerits of every thing they saw, than this general invitation. Every one who looked at the canvass discovered something in the composition essentially wrong, which was retouched, according to their own individual ideas of the sublime or the beautiful. The brush was no sooner laid down than another took it up: it was therefore constantly applied: but when the author called at evening to examine and admire the friendship which had been manifested for his reputation as an artist, there was not a single vestige of the original design remaining. Although all who chose had contributed the pigment which they considered absolutely necessary to perfect the picture, the next day it was unanimously declared that the painter was a man of no ingenuity or knowledge in his profession.

When the Class Book of Anatomy was first published, it was variously criticised by those who gave very clear and distinct rules for constructing a work that should meet with universal approbation. As no such system has made its appearance, and the first of a large edition having been completely exhausted, a second is now given, with considerable additional matter, and the whole care-

fully revised. The Class Book of Anatomy has been introduced into many academies and some of the higher class of seminaries: it is, therefore, confidently believed that it will now be found worthy of a more widely extended circulation.

Some have advised that no scientific terms should be used: but without them the science could not be taught. Others have, with equal strength, urged the importance of resorting to technical words as much as possible. To accommodate the text to the precise plan which different instructers have proposed, would have been a hopeless undertaking. Having taught anatomy and physiology many years, and in different collegiate institutions lectured before classes, the individuals of which, though not expecting to study medicine, were nevertheless required to learn the general principles of these sciences, the plan adopted here was most advantageously pursued.

Time will suggest further modifications and improvements. The author does not suppose this to be the best book that could have been prepared on elementary anatomy: thus far, it is the best that he can make.

Residing on a small island, in the outer harbor of Boston, a considerable part of the year, remote from society, the study of Natural History is a source of never tiring enjoyment. The following pages were written in a succession of otherwise unemployed evenings,—and should they prove a source of pleasure and utility to others, it will be a pleasant reflection that the hours were usefully appropriated.

J. V. C. Smith.

Quarantine Ground, Port of Boston.

October, 1836.

ADVERTISEMENT TO THE FOURTH EDITION.

An increasing demand for this work, which has been extensively introduced into public and private seminaries, has induced the publishers to issue a fourth edition. Each page has been carefully revised, and from the circumstance of a steady and annually increasing demand, the author has not considered it advisable to make any essential alterations in the text, so long as it precisely meets the wants of that part of the community who are in the pursuit of elementary knowledge in this particular department of science.

J. V. C. Smith.

Boston, 1840.

CONTENTS.

ANATOMICAL CLASS BOOK.

Anatomy explains the nature, office, and structure of every part of the human body.

From remote antiquity, men of learning and persevering industry have labored to comprehend and explain the complicated machinery of man, but at no period has the subject been better understood than at the present. By the study of this science, the condition of the species has been ameliorated; extreme sufferings have been avoided; and human life has been prolonged.

On the minds of youth the influence exerted by a contemplation of their own physical condition, founded on a general knowledge of the situation and functions of the different organs, must have a beneficial tendency. As they discover the exact regularity of parts; the beauty and harmony resulting from particular combinations of machinery, endowed with a high degree of vitality, on the action of which health, life, and happiness are constantly depending, it would be strange indeed if they did not fall in humble adoration before that Supreme Intelligence which created and sustains them.

Comparative anatomy implies a dissection of the inferior animals, as birds, fishes, reptiles, and even plants, in order to demonstrate, analogically, the functions of similar apparatus in man. This is an exceedingly useful pursuit, and though philosophers have apparently been guilty of unnecessary cruelties, all their researches have had reference to relieving mankind from some of those

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What is understood by the science of anatomy? What is comparative anatomy?

manifold evils, to which the splendid mechanical organization of the frame is predisposed.

ANATOMY IS DIVIDED INTO NINE PARTS.

Os-te-ol-o-gy,	which	treats	of the	bones.
Syn-des-mol-o-gy,	"	"	"	ligaments.
My-ol-o-gy,	"	"	"	muscles.
Neu-rol-o-gy,	"	"	"	nerves.
Bur-sal-o-gy,	"	"	"	apparatus of the joints.
An-gi-ol-o-gy,	"	"	of vessels, as veins and arteries.	
A-den-ol-o-gy,	"	"	of the glands.	
Splanch-nol-o-gy,	"	"	"	viscera, as the stomach, &c.
Hyg-rol-o-gy,	"	"	"	fluids, as the blood, bile, &c.

OSTEOLOGY.

All the bones, in manhood, are hard, and almost insensible, being composed of earth and lime, held together by means of *gelatin*, a kind of glue, secreted by appropriate vessels. The substance of the long bones, as, for example, those of the limbs, are compact, excepting at their extremities, where they become irregularly larger, and slightly spongy. They are classed in the following manner :—

1. Cylindrical,—bones, as in the arms.
2. Flat,—bones, as in the shoulderblades.
3. Irregular,—bones, as the ribs and those of the skull.

THEY ARE FURTHER SUBDIVIDED INTO,

First,—hollow bones, possessing marrow.
Second,—flat bones, or those destitute of marrow.

Before arriving at about the age of twenty, the ends of the bones are considerably spongy, and imperfectly united to the main shaft, and, therefore, termed *epiphyses*, from two Greek words, meaning *to grow upon;* but afterwards they become firmly united.

The names of a majority of the bones are very arbitrary; some of them, however, have their appellation from a fancied resemblance to some object; others are named from their shape, connexion, or supposed or real use.

What is osteology?
Of what are bones composed?
How are bones classed?
At what age are they complete?
How are bones further subdivided?
What are epiphyses?
How are the names of bones derived?

Every cavity, hole, or prominence, even to the burden of the science, has also a name, a knowledge of which is a key to the parts either directly in contact, or lying in the immediate vicinity.

Protuberances are termed *processes*, and are generally the points of attachment for muscles or ligaments; the first being the moving power, and the latter the bands which keep the ends of any two bones in juxtaposition.

A natural skeleton is held together by the original ligaments; specimens of these kinds of preparations are common.

An artificial skeleton is united together by wires.

In the human skeleton there are two hundred and fifty-two separate bones. People who labor hard have sometimes an extra number, which are formed near the joints of the thumb, fore finger, and toes. They are called *sesamoids*, from their resemblance to the seed of the sesamum plant. They are useful in increasing the power of the muscles wherever they grow.

THE SKELETON IS DIVIDED INTO:

First,—the head.
Second,—the trunk.
Third,—the extremities.

FIRST DIVISION.

There are fifty-five bones entering into the composition of the head, by including thirty-two teeth.

EIGHT BONES IN THE SKULL.

One os frontis,—above the eyes, constituting the forehead.
Two ossa parietalia,—making the sides, above the ears.
Two ossa temporum,—or temple bones.
One os ethmoides,—or sieve-like bone, lying between the brain and root of the nose.
One os sphenoides,—being the bottom of the skull, nearly concealed.
One os occipitis,—at the lower and back part of the head.

What are processes?
What is a natural skeleton?
How does an artificial skeleton differ?
How is the skeleton divided?
How many bones in a human skeleton?
What are sesamoid bones?
Of what use are the sesamoids?
How many bones in the skull?

FOURTEEN BONES IN THE FACE.

Two ossa maxillaria superiora,—the two making the upper jaw.
Two ossa malarum,—or prominent cheek bones.
Two ossa nasi,—one each side, making the arch of the nose.
Two ossa lachrymalia,—just within the angle of the orbit of the eye.
Two ossa palatina,—in the back part of the roof of the mouth.
Two ossa turbinata,—within the nostrils.
One os vomer,—the partition in the centre of the nose.
One os maxillare inferius,—the under jaw.

THIRTY-TWO TEETH.

Dentes.
- Eight incissores,—front, or cutting teeth;—four in each jaw.
- Four cuspidates,—eye teeth, two above and two below.
- Eight bicuspides,—or small double teeth, with two cutting points.
- Eight molares,—grinding teeth.
- Four sapientiæ,—wisdom teeth.

IN THE TONGUE.

One os hyoides,—shaped like a capital U, and situated at the under and back surface of the under jaw, and above the protuberance of the throat.

Four concealed bones of the ear, collectively termed *ossicula auditus.*

Two mallei, malleus,—faintly resembling a mallet.
Two incudes, incus,—or the anvil-shaped bone of the ear.
Two stapedes, stapes, or stirrup,—almost a fac simile of the stirrup of a saddle.
Two orbicularia,—or round bones, but considerably smaller than a mustard seed, and the smallest bones of the skeleton.

SECOND DIVISION.

FIFTY-FOUR BONES OF THE TRUNK.

The *spine*, or back bone, is constructed of twenty-four blocks, called vertebræ,—of which there are

- Seven cervical vertebræ,—or joints in the neck.
- Twelve dorsal vertebræ,—or joints in the back.
- Five lumbar vertebræ,—being larger joints, in the loins or small of the back.

TWENTY-FIVE BONES IN THE CHEST, OR THORAX.

One sternum,—or breast bone.
Twenty-four costæ,—or ribs; the seven uppermost are the true, and the five lowest false, or floating.

How many bones in the face?
How many teeth, and how classed?
Is there a bone in the tongue?
What is its use?
How many bones in the trunk?
What is the spine?
What are vertebræ?
How is the thorax situated?
How many ribs are there?

FIVE BONES OF THE PELVIS.

Two ossa innominata,—or nameless, being the broad hip bones.
One os sacrum,—being the foundation on which the spinal column rests, of a pyramidical figure, with its base upward.
Two ossa coccygis,—the extreme lowest point of the sacrum.

SIXTY-FOUR BONES OF THE UPPER EXTREMITIES.

In the shoulders, { Two *claviculæ*,—collar bones.
Two *scapulæ*,—shoulderblades.
In the arms, two ossa humeri,—between the shoulder and elbow.
In the fore arm, { Two *ulnæ*,—on the under side of the fore arm.
Two *radii*,—on the upper edge.

THE HAND IS DIVIDED INTO

The *carpus*,—or wrist.
The *metacarpus*,—palm of the hand. 2
The *phalanges*,—bones of the fingers. 2

Ossa carpi, or wrist bones, eight in each wrist. {
Os naviculare,—boat-shaped bone. 2
Os lunare,—moon-shaped bone. 2
Os cuneiforme,—wedge-shaped bone. 2
Os orbiculare,—round, or nearly so, bone. 2
Os trapezium,—a geometrical figure. 2
Os trapezoides,—resembling the last bone. 2
Os magnum,—so called because the largest. 2
Os unciforme,—being hooked. 2

Ossa metacarpi,—ten *metacarpal* bones, or roots of the fingers, constituting the palms. Five in each hand.
In the fingers, *twenty-eight* phalanges,—finger bones.

SIXTY BONES OF THE INFERIOR EXTREMITIES.

In the thighs, two ossa *femoris*,—thigh bones.
In the leg, two *patellæ*,—knee pans.
two *fibulæ*,—outside bones of the leg.
two *tibiæ*,—or shin bones.

THE FOOT IS DIVIDED INTO

First,—*tarsus*,—or instep.
Second,—*metatarsus*,—foundation of the toes.
Third,—*phalanges*,—the bones of the toes.

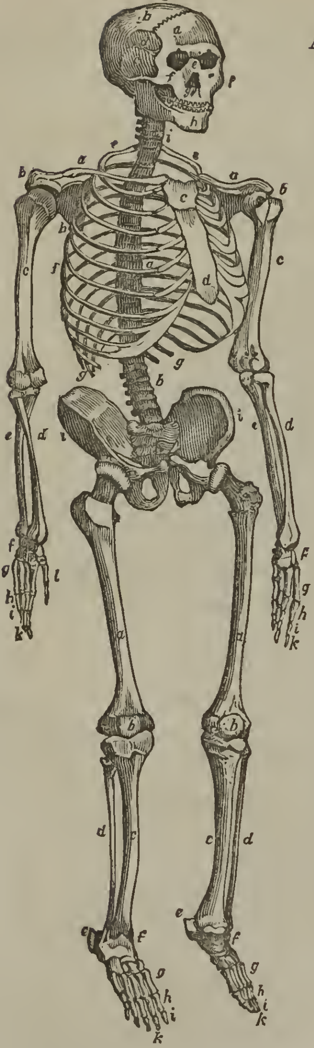
Ossa tarsi or instep. {
Os *calcis*,—heel bone. 2
Os *astragalus*,—making part of the ankle joint. 2
Os *cuboides*,—square bone. 2
Os *naviculare*,—boat-shaped bone. 2
Ossa *cuneiformia*,—wedge-shaped. 6

Ossa metatarsi,—five bones, foundation of the toes. 10
In the toes of each foot, fourteen bones, or phalanges,— 28

Eight bones, the *sesamoides*, in the thumbs and great toes, though not always constant. Total. 252

What bones constitute the pelvis?
How many bones in the superior extremities?
How is the hand divided?
What are the finger bones called?
How many bones in the lower limbs?
How many bones in the foot?
Can you remember their names?

Fig. 1.



A front view of the male skeleton.

HEAD AND NECK.

a, The frontal bone.
b, The parietal bone.
c, The temporal bone.
d, A portion of the sphenoid bone.
e, The nasal bone.
f, The malar, or cheek bones.
g, The superior maxillary, or upper jaw.
h, The lower jaw.
i, The bones of the neck.

TRUNK.

a, The twelve bones of the back.
b, The five bones of the loins.
c, *d*, The breast bone.
e, *f*, The seven true ribs.
g, *g*, The five false ribs.
h, The rump bone, or sacrum.
i, The hip bones.

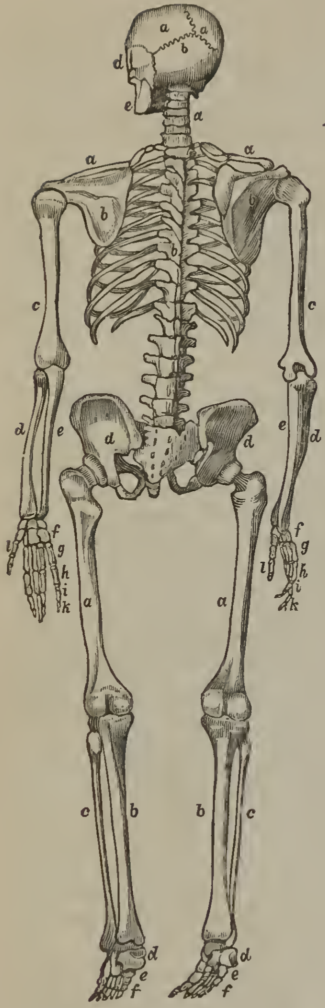
UPPER EXTREMITY.

a, The collar bone.
b, The shoulderblade.
c, The upper arm bone.
d, The radius.
e, The ulna.
f, The carpus, or wrist.
g, The bones of the hand.
h, 1st row of finger bones.
i, 2d row of finger bones.
k, 3d row of finger bones.
l, The bones of the thumb.

LOWER EXTREMITY.

a, The thigh bone.
b, The knee pan.
c, The tibia, or large bone of the leg.
d, The fibula, or small bone of the leg.
e, The heel bone.
f, The bones of the instep.
g, The bones of the foot.
h, The first row of toe bones.
i, The second row of toe bones.
k, The third row of toe bones.

Fig. 2.



2

A back view of the male skeleton.

THE HEAD.

a, The parietal bone.
b, The occipital bone.
c, The temporal bone.
d, The cheek bone.
e, The lower jaw bone.

NECK AND TRUNK.

a, The bones of the neck.
b, The bones of the back.
c, The bones of the loins.
d, The hip bone.
e, The sacrum.

UPPER EXTREMITY.

a, The collar bone.
b, The blade bone.
c, The upper bone of the arm.
d, The radius.
e, The ulna.
f, The bones of the wrist.
g, The bones of the hand.
h, The first row of finger bones.
i, The second row of finger bones.
k, The third row of finger bones.
l, The bones of the thumb.

LOWER EXTREMITY.

a, The thigh bone.
b, The large bone of the leg.
c, The small bone of the leg.
d, The heel bone.
e, The bones of the instep.
f, The bones of the toes.

THE CONNEXION OF BONES.

When united with one another, in a way to admit of motion, the union is termed *diarthrosis.* Bones united in a manner admitting of no motion at all, are said to be connected by *synarthrosis.* And when they are joined by the intervention of any substance, it is called a union by *symphysis.*

The round head of the thigh bone, rolling in its deep socket, is an example of the movable connexion, or *diarthrosis.* All the bones of the head present a union by *synarthrosis.* In the racking or twisting motion of the vertebræ of the spine, we find an illustration of the last division; between every two bones there is an elastic substance to keep them from coming in contact; this is *symphysis.*

STRUCTURE.

All the large, round bones, particularly of the arms and legs, are hollow, for two purposes,—viz. first, because they are stronger for being hollow; and secondly, they are store-houses. The marrow is not placed in the cavities to keep the bones from being brittle, but to supply the system with food when the stomach cannot or does not perform its digestive office.

During a long course of sickness, we take little or no food; but as nutriment must be provided, to keep a proper quantity of blood in existence, the marrow is now carried from the bones and converted into blood. When that has been exhausted, the fat, wherever it exists, is next taken, till the body becomes almost a skeleton.

This is the reason a sick person becomes *poor* and *lean.* A scanty supply of food leads to the same result; hence horses and other animals are *poor*, because they are partly nourished by converting a part of their own bodies into food. As soon as the stomach is abundantly supplied again, and is able to pursue its accustomed labor, the marrow and fat are all returned and packed precisely as they were before.

How are bones connected?
What is diarthrosis?
What is synarthrosis?
What is understood by symphysis?
Where is the marrow lodged?
What is its use in the system?

BONES OF THE SKULL.

The head is divided, in the first place, into *cranium* and *face.*

It is a curious fact, that no two heads are shaped precisely alike; indeed, there is nearly as much diversity in this respect as there are expressions of the face. During the early periods of infancy, the bones are so flexible, that the skull may be moulded into various forms, without injury to the brain. Many barbarous nations, from immemorial time, have practised the art of changing the natural shape of the heads of their children, either to give them some characteristic of the tribe to which they belong, or to render them more beautiful, according to their rude conceptions of that quality. Observation on the natural differences presented in the skull first gave rise to the study of craniology, which has resulted in the science of phrenology.

Calvaria is a term to express the top or convexity of the head. The forehead is the *sinciput*, and the back part the *occiput.*

FOREHEAD.—*Os frontis.*

Having remarked that the skull is composed of eight bones, it is only necessary to describe them individually, in a very general manner. The *os frontis* is a single bone in the adult, though in infancy it was in two pieces. Though thin and delicate, it is in two plates, whose flat surfaces have between them a porous space, called *diploe*, where the blood-vessels are safely lodged for nourishing it. Over each eye it throws out a protuberance, marked by the eyebrows; and within the orbit a thin, sheet-like process juts backward to support the brain from pressing on the globe of the eye. Between the two plates, on a vertical line with the nose, and just between the arched ridges, the two plates recede from each other, so far as to leave a large cavity, the *frontal sinus*, which freely communicates with the two nostrils, although

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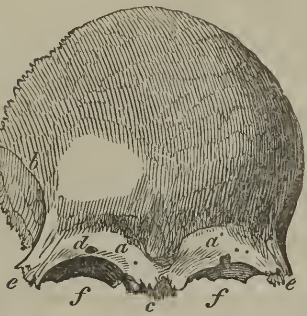
How is the skull subdivided?
At what age are the bones soft?
What is the occiput?
Could the shape of the head be changed artificially?
How, and at what age?
Where are the blood-vessels of the skull lodged?
Where is the diploe?
How is the brain kept from pressing upon the globes of the eyes?
Where is the frontal sinus, and what is its use?
Has the frontal sinus an outlet?

a partition extends from the nose up through the chamber. On this apartment seems to depend the strength of the voice.

Fig. 3.



Explanations of Fig. 3.

Front view of the single bone constituting the forehead; *a*, *a*, mark the place of the *frontal sinus*, or vocal cavity; *b*, the *temporal ridge*; *c*, the *nasal process*, where the bones of the nose are joined; *e*, *e*, the external *angular processes*; *f*, *f*, the orbitar plates, above the eye, to sustain the brain.

It is a drum-barrel, in effect, being for the purpose of reverberating the sound, by which its sonorous power is increased. While suffering from a severe cold, the character of the voice is changed, and it is usual to remark the person *talks through the nose.* This alteration, however, is to be imputed to the closing up of the passage between the nose and sinus, which wholly prevents the sound from penetrating the only spot in which its volume or tone can be increased. Snuff takers, by a vile habit, very much impair, and in protracted cases completely ruin, their voices, by obstructing the canal.

WALL, OR PARIETAL BONES.—*Ossa parietalia.*

These are on one side convex, and concave on the other, and of a square figure. They lie on each side of the head, above the ears, and sustain the office of walls: small holes are discoverable through one or both of them, through which veins return blood to the great canal within the skull.

OCCIPITAL BONE.—*Os occipitis.*

Of all the cranial bones, this is the strongest, thickest, and most compact. It needs to be so, inasmuch as many

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Why is the voice changed by a cold?
How does snuff-taking injure the voice?
Where are the parietal bones?
Which of the cranial bones is strongest?

large muscles on the back of the neck are inserted into it. Its shape is very much like a skimmer, having one large hole in it, about an inch in diameter, through which the spinal marrow passes out from the brain, on its passage down the spine, at the back and lower part of the skull.

WEDGE, OR SPHÆNOID BONE.—*Os sphænoides.*

Being entirely concealed, unless the skull is turned bottom upwards, some difficulty is found in learning its relations. Nearly all writers have compared it to a bat, with wide spread wings. Through it many nerves and vessels pass out; particularly the optic nerves, and those which supply the teeth in the under jaw.

TEMPLE, OR TEMPORAL BONES.—*Ossa temporum.*

On these bones, there being one on each side, the ears are fixed. They stand between the *os frontis*, *parietal*

Fig. 4.

Explanations of Fig. 4.

a, the thin squamous portion of the temporal bone, joining the skull, on a line with the top of the ear; *b*, the *zygomatic process*, which meets the cheek bone; *c*, a cavity in which the lower jaw is articulated; *d*, the external opening of the ear; *e*, the *styloid process*; *f*, the vaginal process; *g*, the *mastoid* process.

and *sphænoid* bones, reaching a little way up the temple. In one part of these irregularly shaped bones the splendid apparatus of the organ of hearing is contained. Here is one quite prominent process, called the *mastoid*, which may be felt behind the ear, to which the muscle is attached that brings the head forward, as in bowing.

Why has the occipital bone a large hole?
Where is the sphenoid bone found?
What particular nerves pass through it?
In what bone is the organ of hearing?
Where is the temporal bone found?

SIEVE, OR ETHMOID BONE.—*Os ethmoides.*

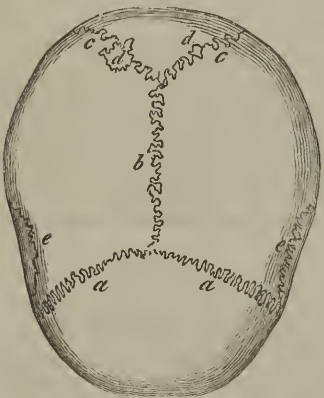
Because it is perforated with many holes, like a sieve, it has received its name. It lies horizontally, on a level with the eyes, over the nose, and has the front lobes of the brain resting upon it. Through the numerous orifices, fine threads of nerves, the *olfactories*, pass into the nasal cavities, to constitute the sense of smell.

SEAMS OF THE HEAD, OR SUTURES.

All the bones of the head are interlocked by ragged edges, called *sutures*. When one overlaps another, as in the case of a part of the temporal over the parietal bone, it is termed a *false suture*. All the true sutures are zigzag lines, seen on the top and sides of the head.

One of these lines, reaching from one ear to the other, over the top of the skull, is the *coronal suture;* so called because an ornament was placed there by the ancients. The *os frontis* meets the ends of the parietal bones to make this suture.

Fig. 5.



Explanations of Fig. 5.

a, a, the *coronal suture; b, sagittal suture; e*, the *lambdoidal suture; d, d, ossa triquetra*, small, ragged bones, occasionally found in some skulls, lying in the last-mentioned suture; *e, e*, portions of the *temporal bone*, overlapping the walls.

On the back of the head, the occipital bone is united to a portion of the temple and the wall bones by the *lamb-*

Through what bone do the olfactory nerves pass out of the skull?
Why is the ethmoid bone so called?
What are sutures?
Are there false sutures?
How is a true suture to be designated from a false one?
Point out the coronal suture.
What bones unite to form it?

doidal suture,—which has its name from its resemblance to the Greek letter L.

Between the parietal or wall bones, exactly on the highest point of the arch of the skull, on a line with the nose, and, consequently, equidistant from both ears, is the *sagittal suture*,—taking its name from a fanciful resemblance to an arrow, lying between the bow and string.

There are several other sutures, but it is not very important to be particular in their description. At birth, the pieces composing the head are small, and imperfectly formed. As we increase in growth, the bones also increase in circumference, till their edges finally meet and form the suture.

When infants labor under a dropsy of the brain, the accumulation of water is often so great, that the head is enormously enlarged. Such a vast collection could not be contained in the head if the bones had been united. Being only slightly attached at different places, or, perhaps, not at all, the membranes on the inside are put upon the stretch, and the bones, offering no resistance, are actually pressed out of place. An enlargement of the head never takes place after the sutures are formed, though there may be a collection of water in the cavities of the brain.

In preparing the skulls of animals for a cabinet, the mode of opening the seams or sutures, that the shape of each bone may be seen, is usually to fill them with dry beans, perfectly full, and after having been placed in warm water, they swell and pry the whole apart.

From infancy to the tenth and twelfth year, the sutures are imperfect; but from that time to thirty-five and forty, they are distinctly marked; but in old age, they are nearly obliterated.

Blows should by no means be given children on the head, either by the hand, as in *boxing the ears*, or by sticks, ferules, and the like relics of the old and obsolete mode of school-government. The entire character and destiny of a child may be altered by a rap on the half-formed skull.

Are there any other sutures on the cranium?
Where is the lambdoidal suture?
Can the sutures be opened?
Are they ever opened by disease?
At what period of life are they perfectly united?

THE BONES OF THE FACE.

For the sake of order, these are separated into those constituting the upper and lower jaw. A minute description of the thirteen bones of the upper jaw would be unnecessary; yet some of the principal characteristics of a few of them will assist the student in obtaining a more exact knowledge of other parts.

UPPER JAW BONES.—*Ossa maxillaria superiora.*

Many irregularly shaped small bones are united to the upper jaw,—as the *palate*, *vomer*, &c. The upper jaw is in two pieces, on the arch of which are situated the teeth, in pits, called *alveolar sockets*, because they somewhat resemble the cells of honeycomb. Just above the angles of the mouth a hard protuberance is felt, where the cheek bone is met by it, which is hollow. Nearly half an ounce of fluid is sometimes secreted in it, in cases of severe inflammation, from diseases of the teeth. Not unfrequently the roots of the eye-teeth protrude quite into it. The name of this cavity is *antrum*. Its use, in common with the one described in the os frontis, is to assist in strengthening the voice.

CHEEK BONES.—*Ossa malarum.*

These stand between the last mentioned protuberance and the outer angle of the eye, contributing to the formation of the orbits.

BONES OF THE NOSE.—*Ossa nasi.*

Two bones, which are merely convex, slender pieces, about an inch in length, meeting in the middle, form an arch, which thus enables the nose to resist hard blows. The partition is one bone, *vomer*, so called from its resemblance to a ploughshare. Sometimes it is twisted more towards one side than the other, giving a crooked

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How many bones are there in the face?
Is the upper jaw a single bone?
What are the sockets called in which the teeth are lodged?
Is the protuberance of the cheek bone solid or hollow?
What bones assist in forming the orbits of the eyes?
Where is the bone called vomer?

or one-sided nose, materially influencing the expression of the face.

Within each nostril there are two distinct bones, called *turbinated*, because rolled up like a roll of parchment. They are thin and porous, and wound up in the manner we find them, to occupy less room. On them is spread the olfactory nerves. in the form of a gossamer-web. By this contrivance surface is gained, without occupying too much space. The turbinated bones in a dog's, lion's, or tiger's nose, were it possible to spread them, would present a broad surface, it is supposed, equal to several square feet; but by being rolled, like a scroll, they can be packed in the narrow canal of the nostril. Man, not being designed to be dependent particularly on the sense of smelling, has small internal nasal bones: quadrupeds, however, are wholly guided in the search and choice of food by this sense; hence the complicated apparatus so much superior to our own. These turbinated bones are liable to disease, and are the seat of tumors called *polypus of the nose.*

TEAR BONES.—*Ossa lachrymalia.*

There is one in each orbit, of the size of the finger nail, having a groove to conduct the tears into the nose.

PALATE BONES.—*Ossa palatina.*

Quite on the back part of the roof of the mouth, these jut backward, towards the throat, having, in life, a curtain or valve suspended to them, which prevents fluids from rushing into the nose in the act of drinking. Usually, accompanying the misfortune of hare-lip, these bones are wanting; which accounts for the want of distinct articulate sounds in such persons.

LOWER JAW BONE.—*Os maxillare inferius.*

All that is particularly interesting in this bone will be discovered in the plate, in which a vast many muscles

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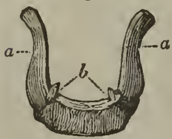
Where are the turbinated bones?
How many of them?
Where is the cavity called antrum?
Of what use are the turbinated bones?
By the sides of what bones are the tears conveyed to the nose?
Where are the palate bones?
Under what circumstances are they sometimes wanting?

will be seen, connected with it. There is a canal, the size of a knitting needle, running through it, from one angle to the other, traversed by a nerve that gives a twig to the fang of each tooth, as it passes along. An artery also makes the same circuit, supplying the teeth with blood.

BONE OF THE TONGUE.—*Os hyoides.*

It is situated in the muscles of the neck, quite in the upper and back part of the throat; its existence would hardly be suspected, were it not felt by pressing with the thumb and finger.

Fig. 6.



Explanations of Fig. 6.

b, merely indicates the places where the arms, or processes, of this bone are united to the body. *a*, *a*, the arms.

Its shape is much like the under jaw, or the letter U, having the diameter of a dollar. Besides being the origin of the tongue, moving up and down, as the tongue is moved, it serves another important office, of keeping the mouth of the windpipe open, like a hoop in the mouth of a sack.

BONES OF THE EAR.—*Ossicula auditûs.*

Each of these, the *malleus*, *incus*, *stapes*, and *os orbiculare*, are minutely described in the article on the sense of hearing.

BONES OF THE SPINE.—*Vertebræ.*

Twenty-four bones, similar in shape, but varying in size, laid one above the other, are collectively called the *spine*. Processes, or arms, extend out on each side, on a line with the limbs; and one projecting backward is the *spinous*, which gives the name to the whole chain. These points are the levers, by which the muscles move the whole, as a column. No one vertebra can be turned on

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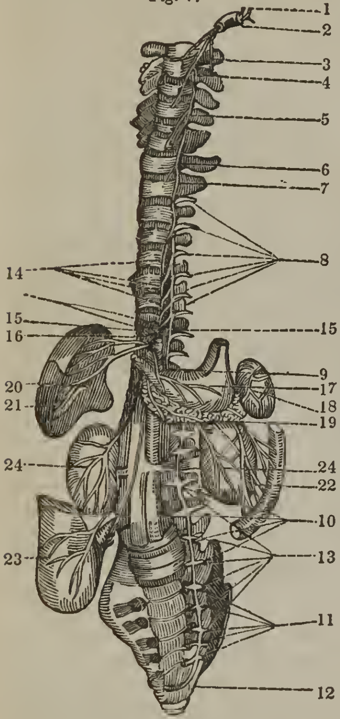
What is the use of a canal in the under jaw bone?
Has the tongue a bone?
What is it called, and where found?
What are the ossicula auditus?
How is the spine constituted?
Why is the bony column called spine?

its axis, but the entire series admits a twisting movement, as demonstrated in all the attitudes which the body assumes. On the back side of the body of the blocks the union of the three arms forms a ring, and the twenty-four present a canal, through which the spinal marrow passes down, giving off nerves between every two bones, to go to the ribs and muscles on the sides.

Fig. 7.



Explanations of Fig. 7.

This shows the connexion of the blocks or vertebræ, constituting the backbone, or spine. All the lines, indicated by figures, from 1 to 24, indicate nerves, which come out between the bones, from the spinal marrow. Fig. 9 is the place of the stomach; 20, the liver; 24, the kidneys; 18, the spleen; 23, the membrane, around the border of which the intestines adhere; 11 and 12 is the bone called *os sacrum*, which, by being prolonged in quadrupeds, is the tail. Man being upright, the bone is short, and curved, and thus holds up the organs, which, by their weight, would otherwise have a tendency to fall through the bottom of the pelvis.

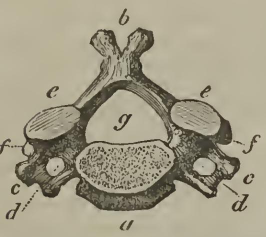
Those of the neck are less confined than those of the back or loins, in consequence of the processes being more horizontal; otherwise there would be an inability to carry the head towards either shoulder.

Between these vertebræ there is an intervening sub-

Has the spine any motion?

stance, exceedingly elastic, convex on both sides, thick in the centre, and thin at the edges, which is analogous to cushions, to prevent a sudden jar in our movements. This is the *intervertebral substance*, rather compressible, yet elastic. After being in an erect position considerable time, the superincumbent weight presses them down thinner; so that a person is shorter at night, after fatigue in walking, than in the morning, after the intervertebral pieces have restored themselves to their original condition.

Fig. 8.



Explanations of Fig. 8.

This is an accurate drawing of one of the bones of the spine, at the neck: *a*, is the *body* of the bone; *b*, the *spinous process*, or handle, which gives the name of spine to the whole column; *c*, *c*, the *transverse processes*, to which the muscles adhere, producing motion; *d*, *d*, round holes, through the arms of the bone, for safely lodging an artery, which carries blood to the brain; *e*, *e*, the upper, and *f*, *f*, the under surfaces, which make a joint with the blocks above and below it; *g*, the hole through which the spinal marrow, or pith of the back, passes in safety from the head, through the whole chain of twenty-four vertebræ.

A person becomes round-shouldered, as the expression is, in consequence of the elasticity of the front edge of these pads being overcome. A permanent stoop or bend of the back is the result. Old age also gradually weakens the elastic power, and therefore aged men are often crooked, infirm, and shorter than in their youth. Distortions of the body, producing deformity, are referable to the want of spring, or proper elasticity, in these cushions.

The topmost of all the bones of the spine is called the *atlas*, because it supports the head, as Atlas was fabled to support the globe. It is a ring of bone, without a body, which distinguishes it from all below it. With the skull it forms a joint, allowing the head to move forward and backward, but in no other manner.

What is the intervertebral substance?
Is it compressible?
Why do some persons become round-shouldered?
At what time are we tallest?
Why are we shorter at night than in the morning?
What name has the first bone of the spine?

Joining the *atlas* is the *dentatus*, or tooth-like bone, having its name from the resemblance which a particular portion of it bears to a tooth. In a full-grown man the process is about half an inch high, above the body of the bone, and smooth, jutting up into the atlas. Around this pivot the head rolls. If, by any sudden jerk, the head is thrown too violently back or forward, the dentatus may be forced from its place; which would be a dislocation, or breaking of the neck, in popular language. When criminals are executed by hanging, the process is commonly torn from its place, presses on the spinal marrow, which, on its way down the back, passes by the side of it, and death immediately ensues.

All the remaining twenty-two separate bones, of which the spine is constructed, are called simply vertebræ.

RIBS AND BONES OF THE CHEST.—*Costæ.*

Twenty-four ribs, seven of which are in contact with the spine behind and the breast bone in front, form the thorax or chest. Each of the ribs has a regular joint, to allow the chest to be enlarged and diminished in breathing. A vulgar notion exists that males have one rib less than females, owing to the circumstance of one of them having been taken from the side of Adam, for the creation of woman:—the number is exactly alike in both sexes.

BREAST BONE.—*Sternum.*

The *sternum*, or breast bone, in the front wall of the chest, is narrow and spongy, not far from an inch and a quarter wide and ten inches long, reaching from the throat to the pit of the stomach.

Several pieces of bone are joined together to constitute it, but the lowest point, which is flexible, is the most interesting. It can be felt with the hand. It is floating, as it were, in the flesh, being flexible and yielding to pressure. As we advance in years, it becomes ossified,

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Where is the dentatus?
How do the movements of these two bones differ?
How many ribs?
Are there joints to the ribs?
Have females more ribs than males?
With what bones are their extremities united?
Describe the location of the sternum.
Is it a single bone, or constituted of several distinct pieces?

and if distorted or forced from its natural place in youth, produces the most painful and alarming consequences in age.

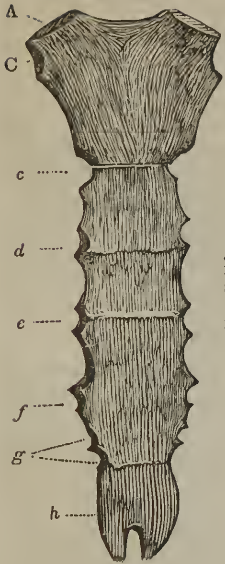
If, for example, a person when seated bends the body habitually forward, it eventually bends the point of the sternum inward, where it will finally remain. The consequence is, the capacity of the chest is diminished, and diseases of the lungs, among a catalogue of other maladies, may result from it. Children should be warned of this liability to disease, before a habit is formed that is formidable when confirmed.

This never becomes solid like other bones, even in extreme old age. Between its perpendicular sides, as seen in the plate, and the front end of the rib, a strip of *cartilage* is interposed, a kind of substance which is familiarly known by the name of *gristle.* The bony wall therefore, over the heart and lungs, is decidedly the weakest part of the frame.

There is a radical defect in the seats of school-rooms in this country. There should be a convexity behind, to fit the hollow of the back. The seat would be more comfortable, and prevent the bones of the chest from being cramped down and binding the digestive organs.

Under what circumstances is it frequently impaired?

Fig. 9.



Explanations of Fig. 9.

A the place where the collar bone is joined; *C* where the first *rib* is articulated; *c*, *d*, *e*, *f*, *g*, show the number of pieces which are united into one: the *ensiform cartilage*, or tip of the sternum, bent out of place very frequently, to the great detriment of the individual, is marked *h*.

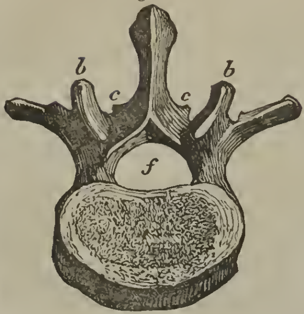
Very small children, in schools, become excessively weary, after sitting a little time on stiff benches—are sleepy, and can scarcely be kept awake. This is nature's mode of seeking relief from the pressure and gravity of the chest, which is confining both bones and muscles. They should certainly be permitted, either to have a recumbent posture, which is thus indicated, or they should be kept but a very little time in one position. Malformation of the bones, narrow chests, coughs, ending in consumptions and death in middle life, beside a multitude of minor ills, have often had their origin in the school-room.

BONES OF THE LOINS.

Five of the last vertebræ, which are the largest and strongest of the spine, contribute to the formation of the *loins* or lumbar region.

How many bones in the lumbar region? Are the lumbar vertebræ different in the structure from others?

Fig. 10.



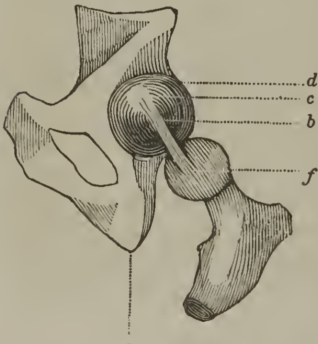
Explanations of Fig. 10.

This is a drawing of one of the *lumbar* vertebræ,—in the *small of the back*, in common language. It is much larger, and contains considerable more substance than those of the back or neck; and it requires to be so, as it necessarily supports the weight of the body above: *a* is the *body;* *b b* the surfaces by which it forms a joint with the block above; *c c* a similar surface, to meet the one below; *d d* the side arms or processes, to which the strong muscles of the back are fastened.

BONES OF THE HIPS.—*Ossa innominata.*

Three bones, the *os sacrum* and the two *ossa innominata* or hips, are so united together as to form a kind of horizontal ring; within this ring, many important organs are found. On the outside of each of the broad, thin hip bones, a deep socket is seen, in which the heads of the thigh bones are articulated.

Fig. 11.



Explanations of Fig. 11.

This is a drawing of the lower part of the hip bone, or *os innominatum*, in which is seen the head of the thigh bone, tied into its socket by a short round cord, to keep it always in place. Were it not for this curious provision, by a thousand unguarded movements the hip would be thrown out of joint. *a* is the membrane which covers the joint; *b* the *cord* that keeps the bone in its socket; *c* the socket in the hip bone; *d* a rim of the socket, to deepen it, and *f* the thigh bone head;—*e* a binding ligament; 6 the point of bone on which we sit.

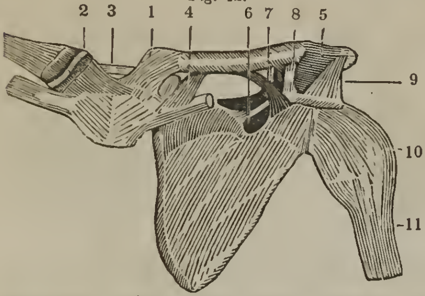
BONES OF THE SHOULDER.—*Scapulæ.*

Lying horizontally, between the top of the breast bone and the tip of the shoulder, above the joint, is the *clavicle*, or collar bone, shaped something like an italic *s*. Its use

Where are the ossa innominata?

is to keep the arms from sliding forward, towards the breast; and it is also useful in sustaining burdens, as when a basket is carried on the shoulder. Its name is said to have been derived from its resemblance to an ancient key.

Fig. 12.



Explanations of Fig. 12.

In this cut is seen the union of the shoulder-blade, collar bone, breast bone and the shoulder joint. These are detached from the body; hence the view is a front one. A portion of the collar bone of the right side is seen also,—all the others being on the left side. The figures from 1 to 11 indicate the ligaments which keep them united, when the muscles are dissected away.

Shoulder-blade is a familiar name of a thin, broad, triangular bone, behind each shoulder, termed *scapula.* At the highest angle, a hooked process stands out, which makes a roof, as it were, over the shoulder joint, to defend it from violence by the pressure of burdens. At its root, and necessarily on its under side, is a depression called the *glenoid cavity*, in which the head of the shoulder is articulated, to make the joint. The shoulder blade does not touch the ribs, nor has it any attachment with any other bone than the clavicle, belonging to the chest. It lies on a cushion of a muscle, and is moved in various directions in every motion of the arm. If the arm is raised, carried either forward or backward, down or up, the motion of the shoulder blade may be distinctly felt through the skin.

BONES OF THE ARM.—*Ossa humeri*,

Os humeri and *os brachii* are names given by the books to the arm bone. At the upper end is a large ball, that rolls in the socket of the shoulder-blade; and at the other extremity it is flattened to receive the fore-arm,

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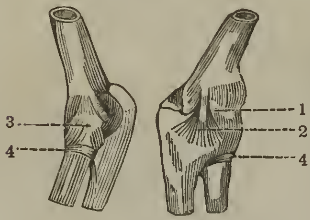
Point out the place of the scapula and its relations.

with which it makes a *ginglymus* or *hinge joint*, admitting only of two motions, flexion and extension, similar to motions described by a door, swinging on its hinges. To this bone a principal part of the muscles are attached which produce the movements of the limb.

Fig. 13.



Explanation of Fig. 13.

Short ligaments of the elbow are here demonstrated: the wonder is, how the elbow joint can ever be dislocated, without entirely ruining the whole ligamentary arrangement. The figures from 1 to 4 not only give the locality of each ligament, but even the figure.

BONES OF THE FORE-ARM.—*Radii et Ulnæ.*

Two bones are in the fore-arm, between the elbow and wrist, lying side by side: that on the upper side, on a line with the thumb, is the *radius*, so named from its resemblance to the spoke of a wheel. It is sometimes termed the *manubrium manus*, or handle of the hand, because the hand is fastened to its lower end, and its upper one has but little or nothing to do with the composition of the elbow joint. The radius rolls to and fro, carrying the hand with it, while its fellow, *ulna* or *cubit*, so named because it was used for a measure, is curiously articulated to the elbow, but does not reach the hand.

On these two bones a vast number of complicated muscles take their rise, which produce the multitude of short, quick or strong motions of the hand and fingers.

When the palm of the hand faces backward, it being supposed that the arm is pendulous by the side, it is called *pronation*. When it faces forward, the thumb being outside, it is *supination*. Those muscles which produce these movements are *pronators* and *supinators*.

BONES OF THE WRIST.—*Ossa carpi.*

Eight little bones, whose shapes cannot well be described, placed in two rows, form the wrist. On the back side

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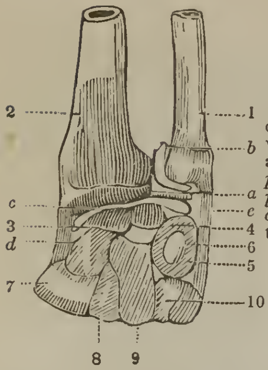
Is there more than one bone between the shoulder and elbow? Give its name.
What sort of a joint has the upper extremity of the arm bone?
How many bones in the fore-arm?
What do you understand by pronation?
What by supination?
How many bones in the wrist?

Fig. 14.

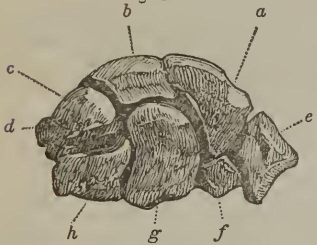


Explanation of Fig. 14.

This diagram shows the connexion of the little bones of the *carpus* or wrist, with the two long bones of the fore-arm. 1 the *ulna;* 2 *radius;* 3 *scaphoides;* 4 *lunare;* 5 *cunciforme*; 6 *pisiforme;* 7 *trapezium;* 8 *trapeziodes;* 9 *magnum.* The letters mark the ligaments which tie them together.

they are arched, actually reminding one of irregular sized stones, so put together as to resemble a piece of masonry. On the inside they make a canal, through which the tendons of the muscles glide along to the fingers.

Fig. 15.



Explanation of Fig. 15.

Another plan of the bones of the wrist, showing them placed in two rows. This is a back view of the carpus of the right hand. *a* the *boat-shaped bone;* *b* the *half-moon shaped;* *c* the *wedge-shaped;* *d* the *pea-shaped;* which make the upper row, joining the fore-arm. In the second row are the four others, which are united by a joint to the palm of the hand.

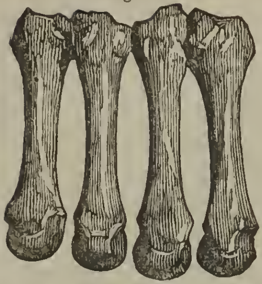
Their names are *naviculare*, *lunare*, *cuneiforme*, *orbiculare*, *trapezium*, *trapeziodes*, *magnum*, and *unciforme*.

BONES OF THE PALM.—*Metacarpus.*

A detailed account of the shape and size of the bones of the *metacarpus*, or palm, would seem to be unnecessary, as every person can ascertain their number and relations by feeling his own hands; the plan, however, is inserted.

Explain the metacarpus.

Fig. 16.



Explanation of Fig. 16.

Four metacarpal bones, side by side, precisely as they are placed, and of the true shape, forming the palm of the hand, are seen in this figure. The metacarpal bone of thc thumb is scen in Fig. 17, marked *a*.

Fig. 17.

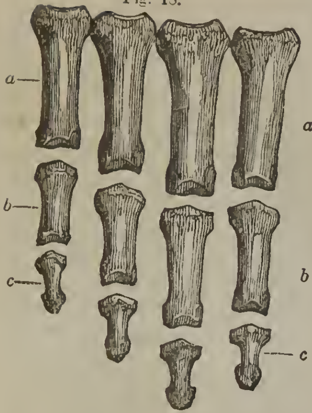
Explanation of Fig. 17.

There are but three bones in the thumb, which are larger than those in the fingers, because it was designed to oppose them, and therefore possesses a structure quite different. To these three, five muscles are attached. *a*, *b*, *c*, are the threc, but it should be recollected that *a* really belongs to the metacarpus, so that

Only two bones exist in the thumb, but there are three in each finger,—collectively called *phalanges*, being fourteen in number.

Explain the phalanges.
How many phalanges?
How many bones in the thumb?
Why are the bones of the thumb large?
How many muscles belong to the thumb?
How many bones in the carpus?

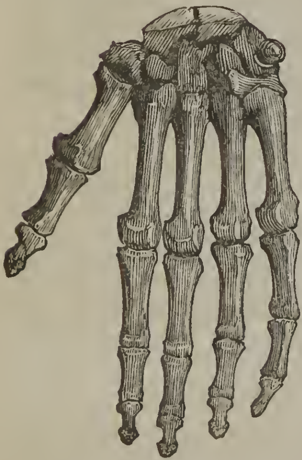
Fig. 18.



Explanation of Fig. 18.

Twelve bones, as exhibited in this plan, constitute the fingers of one hand. They are separated from each other, that the exact form of the extremities of each may be seen. *a* the first bone of the little finger, *b* the second, *c* the third: the same letters point out the three, also, composing the index, or fore finger.

Fig. 19.



Explanation of Fig. 19.

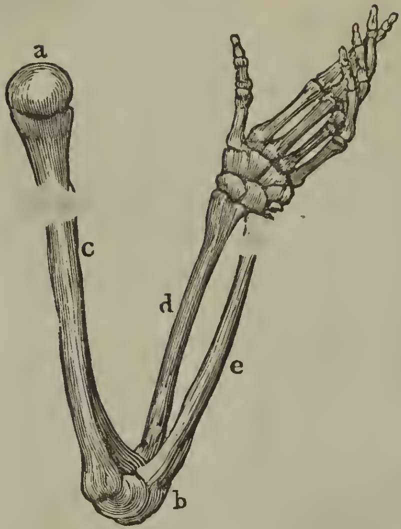
Here is presented a back view of all the bones of the hand, as they are connected with the eight little bones of the wrist. Each bone is so distinctly represented, that a very young child may understand the arrangement.

How many bones are there in the whole hand?

Point out the carpus.

NOTE. The extensor muscles are placed on the back side of the hand and fingers, and the flexors inside.

Fig. 20



Explanation of Fig. 20.

All the bones of the arm, fore-arm, and hand, are here exhibited in connexion, with reference to impressing it on the mind, after having read a short description of the individual parts of the upper extremity. *a* is the head of the arm bone, articulated to the shoulder; *b* the joint or elbow, formed by the *ulna* and lower end of the arm; *c* the shaft of the *os humeri* or arm; *d* the *radius* or handle of the hand, united, solely, to the wrist; *e* the *ulna*, which alone forms with the arm the joint.

BONES OF THE INFERIOR EXTREMITIES.—*Ossa femoris.*

First, the *os femoris*, or thigh bone, is the largest and longest in the skeleton: it needs to be, as it sustains the whole body. The ball, by which it is articulated in the deep socket of the hip bone, appears to be at the end of a branch, standing out at a considerable angle from the shaft, as seen in the engraving of the skeleton. This is the *neck* of the *femoris.* Its lower end, or *condyle*, is quite large, to make a part of the knee joint. All the muscles assisting in running, walking, or dancing, are variously connected with it.

BONES OF THE LEG.—*Tibæ.*

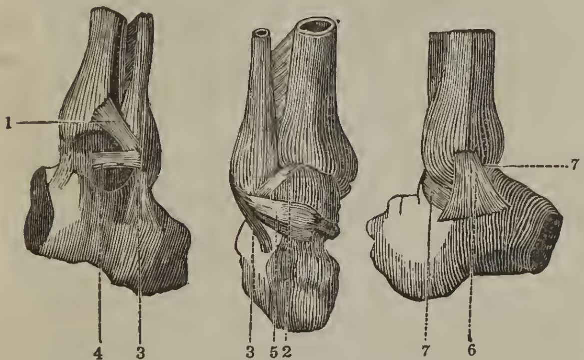
Tibia is the scientific name of the shin bone, because it was thought to look like a pipe. United with the condyle of the thigh bone, assisted only by the kneepan, it forms the knee joint.

Where is the largest bone in the body?
What muscles, particularly, are attached to the femoris?
Has the leg two bones, like the fore-arm?

At the ankle it is admirably fitted to the *astragalus*, to permit flexion and extension of the foot, as in walking. A piece or splint, called *malleolar process*, slides down by the side of the joint, to increase its strength. The process may be felt, being under the skin like a knob, on the inner side of the ankle.

This joint is very securely arranged, to prevent luxations; as it merely moves in two directions, backward and forward, nothing short of a degree of violence that injures the bones can materially affect it. Besides ligaments, the tendons of many muscles contribute to its security, strength, and perfection.

Fig. 21.



Explanation of Fig. 21.

These three plans show how the two bones of the leg are united above the ankle joint. 1, 2, 3, 4, 5, 7, 7, 6 mark the ligaments which bind them firmly.

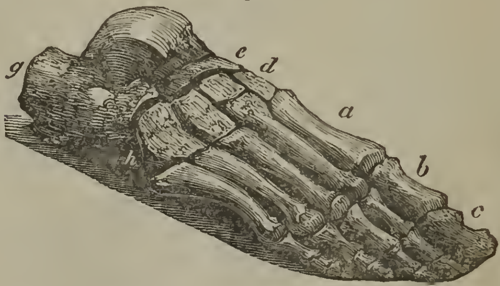
Outside of the tibia is a long, slender bone, the *fibula*, lying on the side of the head of the tibia, but having nothing to do with the knee joint; it passes down past the ankle joint, giving the same security to it that is afforded by the *malleolar* process of the tibia, on the inside. Between the two bones all the muscles—and they are numerous—arise which go to the foot and toes.

What is the use of the malleolar process in the economy of the joint?
Where is the fibula?
What is the use of this bone?
Where is the bone found called the tibia?
How many bones enter into the composition of the knee joint?

BONES OF THE INSTEP.—*Ossa tarsi.*

Five bones are found in the *tarsus* or instep, one of which is nearly all given to the heel. An arch is formed by the other four, similar to the wrist, giving a convexity

Fig. 22.



Explanation of Fig. 22.

By this diagram the skeleton of the foot will be clearly understood, even without the aid of the bones. Twenty-six bones are here so curiously grouped together, that an arch is made between the heel and ball of the great toe:—*a*, shows the five bones of the metatarsus; *d*, *e*, *f*, *g*, and *h* point out the five bones of the instep or *tarsus;* *b*, *c*, and *i*, indicate the phalanges or toes.

to the top of the foot. On the under side, in the sole of the foot, all the flexor muscles of the toes are found. This structure conduces to the elasticity of the step, and the weight of the body is transmitted to the ground by the spring of the arch, in a way to prevent the injury of numerous organs by a sudden jar. Each one of them has a specific name; viz. *os calcis*, the heel; *astragalus*, being part of the ankle joint, named from its likeness to a block used by the Greeks in playing a game of chance; *cuboides*, or square bone; *naviculare*, the boat-shaped; and *cuneiforme*, or the wedge-shaped bone.

As in the hand, between the instep and toes is the *metatarsus*, in which are five bones, placed like the sticks of a fan, articulated with the first row of the bones of the toes.

Precisely as the short blocks of bones are arranged in

How many bones in the instep?
Do the bones of the foot constitute an arch?
Name the small bones of the instep.
Where are the flexors of the foot lodged?

the thumb, so they are in the great toe, being, however, proportionably larger. There are two in this and three in each of the four remaining toes; the whole of which are *phalanges*, being fourteen in all.

Fig. 24.

Fig. 23.

Explanation of Fig. 23.

This represents the bones of one toe, as they stand in relation to each other:—*a* the metatarsal part, concealed in the muscles, and *b c d* the three phalanges.

Fig. 24 is the skeleton of the great toe: *a* the metatarsal portion, and *b c* the phalanges.

Sesamoid bones, considerably larger than in the thumb, are discoverable on the under side of the first joint of the large toe.

INVESTING MEMBRANE OF THE BONES.—*Periosteum.*

Over every bone is a thin, white covering, the *periosteum*, closely investing it. Its use is to conduct the nutritious vessels and nerves into the substance of the bone. It serves also for the attachment of the muscles, which could not otherwise be fastened to the smooth surface. Though apparently insensible, it is amply furnished with nerves, arteries, and veins, but its vitality is very low.

What and where is the metatarsus?
What are *sesamoid* bones?
Of what use are they?
What do you understand by periosteum?
Is it particularly necessary?
How many phalanges in the foot?

GROWTH OF THE BONES;—*or Osteogony.*

By this term is understood the formation and growth of the bones. From infancy till the age of about twenty years, they are constantly undergoing changes. In fact, they are completely renewed many times in the course of a long life. No particle of matter can long remain at rest in a living system. When one portion is removed another is put in its place; so that, by the circulation of the blood, the greatest activity prevails, even among these earthy portions of the body.

The arteries carry whatever is necessary to promote the growth or to repair the waste of the system. They also fashion each organ, give shape to every bone, and sustain and furnish them with vitality.

Bones have nerves, but they are small, and only connect them with the other more highly organized parts. When they are diseased they become painful as the muscles; but in health they are insensible.

As a whole, the skeleton is merely a frame, on which are suspended, or attached, all the organs of motion. It is full of joints; and each bone is a lever to be acted upon by the power of a muscle. This, which in most of the large animals is in the centre, in many of the smaller tribes is on the outside, in the form of a shell. Examples may be found in the turtle and lobster, beetles, &c.

Such a remarkable piece of mechanism as the skeleton, even divested of a thousand important, wonder-working accompaniments, exhibits in the clearest light the goodness and wisdom of God. The fashion of each bone, and, above all, the skilful and nice adjustment of the whole, and their subserviency to the different fibres and tubes which are intimately connected with this complicated, yet perfect piece of architecture, must strike a reflecting mind most forcibly.

DIFFERENCES BETWEEN MALE AND FEMALE SKELETONS.

Were it true that men have a deficient number of ribs, there would be no difficulty in designating the skeletons

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Explain the definition of the term osteogony.
Are the bones ever renewed?
What vessels fabricate the bones?
Have bones sensibility?
Are they nourished by blood?
In what classes of animals is the skeleton outside instead of being clothed with flesh?
Are the bones levers?

of different sexes. To an inexperienced eye it will always be a nice point to determine one from the other.

The skeleton of the male is larger and heavier than that of the female. The surfaces of the bones are rougher, as the muscles which moved them are more strongly developed, and capable of exerting more power than those of the other. The head of the female, on an average, is smaller than the male; the sutures are less notched; and the cavities in the bone of the forehead and upper jaw bones are considerably smaller. All the limbs are more delicately and slenderly formed. Processes are less prominent, and depressions are comparatively more superficial.

A still stronger difference, however, is found in the pelvis,—a kind of arch, or bony circle, bounded by the hip bones. In females the pelvis is much broader than in men, and the hips are spread more outwardly. Lastly, the necks of the thigh bones are longer, giving them the appearance of being particularly broad across the hips. Thus far only females are constructed, in the frames of their bodies, to differ very essentially from the male. The breadth of the pelvis, in connexion with the peculiarity of a long neck to the thigh bones, brings the knees nearer together.

If two skeletons, one of a male, the other of a female, are suspended, it will be noticed that the lower extremities of the male would be nearly parallel to each other; whereas, in the other, the knees will approximate so nearly as to touch. Another difference consists in the capacity of the chest: one is small, and the other is large. The bones of the feet and hands are large in men; but in the female they are slender, smooth, and delicate. Finally, the height and weight would have an influence upon our judgment in deciding upon the character of either.

DISTORTIONS TO WHICH THE BONES ARE LIABLE.

Many injuries of the bones are induced by the carelessness of nurses, in infancy and the first years of childhood, which have a permanent influence on the figure and

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How does the male differ from the female skeleton?

How may injury of the bones be produced?

health in after life. Females especially, by the caprice of fashion, are the subjects of many alarming diseases, arising from distortions of the bones. One of the most serious affections, a distortion of the spine, is much oftener found in females than in males. Boys generally lead an active life, enjoying a free exercise of all their limbs in various pastimes. Girls, by a perverse custom, are taught that they were made for the house, and not for the open air. Their employments are therefore commonly of a sedentary kind, confining them to one posture many hours at a time. Added to this, which is enough to enfeeble any constitution, instead of naturally expanding, to give full play to the lungs, the chest is kept from enlarging its capacity, by stays and closely fitted dresses. The ribs are pressed inwardly, the spine prevented from having motion, the lungs cramped; and consumptions, inflammations, and other oftentimes incurable maladies, are the certain results.

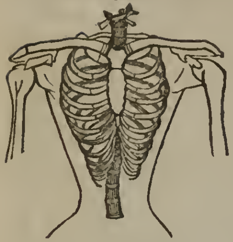
Notwithstanding the odium cast upon the Chinese for their ridiculous fancy for the small feet of their females, which are prevented from growing by being compressed in iron shoes, it is not so cruel nor absurd as the practice among the females of all civilized countries, at the present day, of preventing the growth of the waist.

Physicians, philanthropists, and philosophers, have each exerted themselves to awaken an interest, to arouse females to a sense of their danger; but it has been to little purpose. Though seriously deformed, they cannot be persuaded to abandon a custom, which, in their apprehension, improves their otherwise beautiful forms.

Young ladies require nearly as much exercise as boys, but of a less violent character. They require loose, easy clothing, that the bones concerned in the formation of the apartment in which is placed the vital apparatus, may be free and unrestrained.

Do females require as much exercise as the other sex?
Why should clothing be loose and easy to the body?
Why are distortions of the bones of the chest most frequent in females?
Do boys ever suffer from distortion of the bones?

Fig. 25.



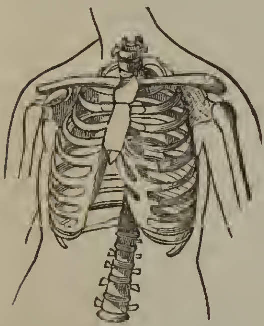
Contracted chest.

An outline is here presented of the chest of a female, to show the condition of the bones, as they appear after death, in every woman who has habitually worn stays.

All the false ribs, from the lower end of the breast bone, are unnaturally cramped inwardly towards the spine, so that the liver, stomach, and other digestive organs in the immediate vicinity, are pressed into such small compass that their functions are interrupted, and, in fact, all the vessels, bones, and viscera, on which the individual is constantly depending for health, are more or less distorted and enfeebled.

Whatever has a tendency to confine those parts of the frame which were designed for motion, positively tends to

Fig. 26.



Skeleton of a well formed female chest.

By comparing the accompanying plan of a well developed and naturally proportioned female chest, with the frightful skeleton appended to the preceding note, the difference is strikingly apparent. Here is breadth, space for the lungs to act in; and the short ribs are thrown outwardly, instead of being curved and twisted down towards the spine, by which ample space is afforded for the free action of all those organs which in the other frame were *too small to sustain life*. The first may be regarded as the exact shape and figure of a short-lived female; and this may be contemplated as an equally true model of the frame of another, who, so far as life depends upon a well-formed body, would live to a good old age.

the production of disease; it is therefore of the highest interest to the well-being of our species that an elementary knowledge of the structure of the human body should be taught, and everywhere understood, that precautions may be taken to avoid a threatening danger. Physical education is not only too much neglected, but, what is still more lamentable, scarcely appreciated in this country. If parents, in the first place, and instructers in the second, studied more the education of the body, the intellectual faculties would be more fully and energetically developed. Above all, the young should be instructed correctly in the knowledge of the laws of animal life.

The lungs, too, suffer; and in those cases, *which are ninety in a hundred*, where stays have been laced on in very early life, before the ribs have become perfectly *ossified*, the chest is never developed; it never assumes the form which it would have had, were it not for this mechanical restraint; consequently, for want of capacity, or, in other words, for the want of room, the lungs are too small for the requisitions of the body; they cannot oxygenate the blood,—an indispensable vital process.

Corset-boards are quite as reprehensible, though the injuries to which they give rise are less apparent in the beginning. The busk operates almost exclusively on the *sternum* or breast bone, which is easily bent out of its original position at its lower extremity.

By a constant pressure of an inelastic board, the lower end of the sternum, which juts down into the abdominal muscles two or three inches, is forced inward, and becoming ossified in that direction, is productive of serious injury to the stomach, which lies just behind it.

A multitude of painful and protracted diseases, by which thoughtless females, in this age, are hurried to an early grave, have their origin in this horrible custom of wearing stays. Thousands upon thousands of young ladies are the yearly victims, even in the United States, to *consumption*, which is wholly referable to this fashionable taste of conforming to a practice which has for its object *the improvement* of the female form; as though the Creator, in constructing the most beautiful work of his creation, neglected to give that finishing process, which they imagine themselves to have discovered, and which can alone be satisfactory to the sex.

While we lament the tolerance of an evil in our country that sweeps the young, the beautiful, and the intelligent to the tomb before the summer of life has fairly commenced, we scarcely indulge the hope of a reformation: pernicious customs which are preserved by common consent, cannot be easily overcome by persuasion or argument.

If, notwithstanding the many illustrations given of the sad effects of stays and busks, by various philanthropic writers, mothers and nurses manifest no disposition to be

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Do the lungs ever suffer from distortions of the bones?

How can the breast bone be distorted?

influenced by their opinions and advice, the duty most certainly devolves on all public teachers, in a delicate and appropriate manner, to instruct their pupils in the first principles of preserving health, by explaining their morbid effects.

One of the first lessons in physical education should be to strip from the pupil every unnecessary restraint upon the body and limbs.

TEETH.

In manhood there are thirty-two teeth, divided in the following manner:

8 Incisores,—or cutting teeth.
4 Cuspidati,—or canine teeth, being pointed.
8 Bicuspides,—or two-pointed double teeth.
8 Molares,—or grinding teeth.
4 Dentes sapientiæ,—or wisdom teeth.

The first set, or milk teeth, are twenty in number, appearing from time to time, from the age of about ten months to three years, when they are all developed. There are, however, many variations as respects the period of cutting them, depending on constitutional causes. When the roots are absorbed the tops fall off from the gums, and the second set are protruded. The jaws, in the mean time, become longer and broader, which allows room for an increased number, of a greater size.

In the centre of each tooth is a cavity, in which the pulp of a nerve lies, and which is the seat of pain, when the body of the tooth is so decayed as to expose it to the air, or bring it in contact with food. Each root is also hollow, allowing the fibre of a nerve to communicate with the nerves of the jaw; and blood-vessels also run in by the side of it, to nourish the whole.

The *enamel* is the outside, hard crust, which gives the requisite finish to the tooth, and renders it strong enough for mastication. This enamel is much thinner on the teeth of some persons than on others, and scaling off, the bony part of the teeth, being exposed, soon falls into disease by the contact and influence of various kinds of food, drink, heat and colds.

How many teeth in the human jaws?
How are they anatomically divided?
What are the milk teeth?
Why is the tooth furnished with a cavity?
How are the teeth protected externally?

Acids of all kinds are particularly injurious to the teeth, because they act chemically on the lime contained in the enamel, destroying the connexion of the particles, and thus ultimately exposing the nerve. Hot drinks are also pernicious.

Individuals living on moderately cool food, and drinking cold water simply, preserve their teeth in all their original beauty and goodness to an advanced period.

Sugar is not destructive to the teeth, as generally supposed: slaves on sugar plantations possess the finest sets, uninjured, apparently, to extreme old age.

Cold water only is advisable, applied with a soft brush, for keeping them white, clean, and in a healthful condition. The various dentifrices, salt, ashes, charcoal, &c., actually injure them by attrition in the application, and should never, therefore, be used. Chewing and smoking tobacco is very destructive to the teeth. To youth these few practical considerations are worth their recollection.

When the teeth are all extracted, the sockets which supported them are absorbed; and hence the jaws are narrower; which explains the reason why in old age the mouth is smaller and the lips sunken: it also accounts for the difficulty with which words are articulated. The tongue, being compressed, moves with less freedom, and distinct enunciation becomes extremely difficult.

LIGAMENTS.

SYNDESMOLOGY.

The skeleton would have been in a very imperfect condition if so many bones were not firmly connected together. The bands and straps which connect them are called *ligaments*, and *syndesmology* is the study or doctrine of them.

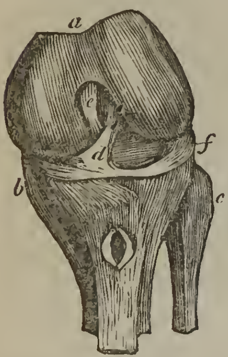
Are acids injurious to the teeth?
Is sugar destructive to them?
What application is most approved of for their preservation?
What becomes of the sockets after the extraction of the teeth?
Are the ligaments of much importance?
Define the term syndesmology.

Such is the tenacity of the ligaments, that the bones are sometimes fractured, before they are torn from their points of adhesion.

Ligaments, like the bones themselves, are nearly insensible, white, and shining, and commonly short, thin, and tough. Where the ends of two bones meet, as in the construction of a joint, their situation is maintained by ligaments running from one to the other. Possessing but a very slight degree of elasticity, the joints do not become loose, unless extension is maintained a very long time.

Were it not for ligaments, the bones of our bodies would fall down by their own weight. A natural skeleton is one on which they have been preserved, with reference to showing the precise connexion of the bones.

Fig. 27.



Explanation of Fig. 27.

e, *d*, are the *crucials* or cross ligaments, remarkable in structure and office; *f*, the tendon of an extensor muscle; *c*, the head of the *fibula*, joining the side of the shin bone; *a*, the articulating surface of the lower end of the thigh bone, covered by the kneepan; *b*, refers to the broad ligament, turned down from the joint to expose the cross ligaments, having the knee pan on it.

Some ligaments keep a joint from bending the wrong way. The knee would be the weakest, and most liable to get out of order, of any joint, were it not for its numerous ligaments.

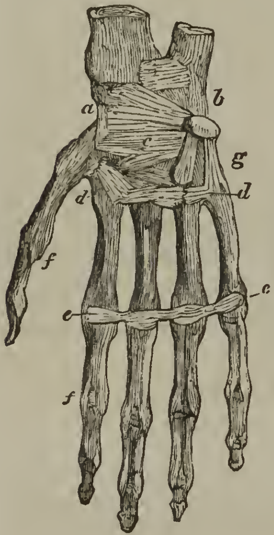
Within this joint two ligaments are so arranged, that they cross each other, like the legs of a saw-horse, completely preventing the leg from being carried too far backward or forward. The lateral ligaments guard against dislocations on either side.

Have ligaments sensibility?
How are natural skeletons made?
What have ligaments to do with the joints of the body?
What prevents the knee from being a weak articulation?

One single round ligament fastened on the head of the thigh bone ties it into the centre of its socket, keeping it always in place, however much the limb be moved in opposite directions.

Ligaments exist wherever two bones meet at their extremities, and also abound in the cavities of the body, in the form of flat or round cords, to sustain the weight of important organs, as the liver, spleen, and pancreas. Without these supports the liver would inevitably fall down, from its place just under and behind the false ribs of the right side, upon the hollow organs below. The

Fig. 28.



Explanation of Fig. 28.

Complex as the ligaments appear in this plan, there is certainly an admirable simplicity, conducing exactly to the perfection of the frame of the hand. Each letter, as in other diagrams, shows the place of each ligament, as found on dissection, joined to the bones, which are thus drawn together like so many wedges. It would be impossible for the most ingenious mechanic to take the dry bones and secure them together by wires, clasps, rivets or straps, so strongly as nature has done by means of these little shining ligaments.

gall-bladder is tied to the liver by a ligament; the intestines are kept in their places by ligaments; the stomach, too, without ligaments would soon be thrown by its own muscular exertions, during digestion, from its natural locality. Even in the skull, ligaments, assuming various forms, support the lobes of the brain, protect vessels, and

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How is the thigh bone kept in its socket? By what contrivance are the bones of the palm kept in exact place?

give strength to the head during the first years of life. Indeed, ligaments are indispensable throughout the animal frame.

By means of them the small bones of the foot are kept firmly together in the shape of an arch in the instep: otherwise the weight of the body, in walking, would crush them apart, and forever destroy their curious connexion.

Fig. 29.

Explanation of Fig. 29.

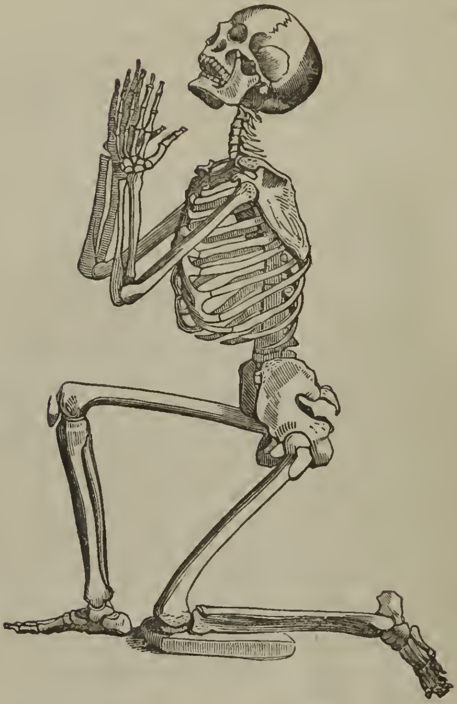
By this drawing, which is true to nature, it will be seen, distinctly, how the bones of the instep and ankle are articulated; how the instep and phalanges or toe bones meet; and lastly, the small letters direct the eye to the locality of each ligament, which assists in binding this congeries of large and small blocks firmly together, like a pavement.

In cases of club-foot, the ligaments are very much deranged, in consequence of the distortion and displacement of the bones. But, however formidable the case may appear, if seasonable exertion is made, the very worst club-foot may be remodelled by an iron shoe, provided with metallic rods running up by the sides of the ankle, so that both the apparatus and bones may be kept in place. Without the advice of a surgeon, any ingenious mechanic can remedy a malformation of the foot, if the trial is commenced while the bones are imperfectly ossified.

By ligaments the wrist is fastened to the arm, independently of muscles; the shoulder to the shoulder-blade; the head to the first bone of the neck; the ribs to the spine; and the vertebræ to each other. The office, therefore, which these deep-seated, almost unnoticed straps hold, in binding the whole frame together, cannot be overlooked by any one who contemplates the marvellous work of God.

How is it with respect to the construction of the foot? Explain the nature of club-foot.

Fig. 30.



Explanation of Fig. 30.

Having completed a general description of all the individual bones, and exhibited some of the principal ligaments of the limbs, the object of this third drawing of an entire skeleton is, first, to give a side view of the parts adverted to in the foregoing pages, without letters or references to deface the engraving, or to perplex the mind. The peculiar attitude of the figure was given it by the artist, merely because a larger sized drawing could thus be given in a little space.

THE MUSCLES.

MYOLOGY.

An interesting department of anatomy is called *myology*, or the doctrine of the muscles.

We would by no means surfeit our young readers with the consideration of subjects which are only considered valuable to the anatomist: but we wish general inquirers to participate in some of those sublime manifestations of the all-creative Power, presented in the mechanism of animal bodies, which have too long been locked up in libraries.

All that pertains to anatomy, either human or comparative, possesses the highest degree of interest.

We are not so enthusiastic as to suppose that every one can feel as earnestly devoted to this science as ourselves; nor is the desire entertained of making dry bones a fashionable topic of general conversation; but we most fervently hope that the leading principles of anatomical and physiological knowledge will be diffused; will yet be taught in all the schools of this country.

It will lead the young to correct views; it will dispel that vulgar kind of mystery in which the functions of individual organs are enveloped; it will strengthen the morals, elevate the mind, and be one of the surest means of fixing the attention to the considerations of the character and omnipotence of God.

The desire and the hope to prolong the period of life, to raise the dead, and to avert disease, has always been founded on a limited and false knowledge of anatomy. Those who are truly learned in the science, discover the impossibility of maintaining never-failing youth: they are convinced of the necessity of death, the only means of allowing a succession of beings; the only means by which matter can assume the forms that insure this unfailing result.

Are there any advantages to be derived from the study of anatomy?

What is myology?

Our bodies are indeed marvellously constructed. The materials of which they are composed possess the most opposite characters, and the effects produced by the harmonious operation of each fibre, however minute or remote, contributes something towards the perfection of the whole. The moving powers, the self-acting levers, and the invisible something which guides the movement, or limits the duration of action, belong to another inquiry; yet, before arriving there, it is first necessary to investigate the instruments of motion, the *muscles.*

MUSCLES.

There are five hundred and twenty-seven muscles in man, two hundred and fifty-seven being in pairs.

Wherever there is a joint to be bent, a bone to be moved, or a motion of any kind to be effected, it is entirely executed by muscles. Muscles are, in popular language, *flesh;* but instead of being an irregular mass, as too commonly supposed, a certain number of threads are invariably deposited, with systematic attachments, with reference to a specific kind of motion.

Each muscle is formed by an exact rule, from which nature never departs without exhibiting a monster, whose motions are so far a deviation from the species, that the individual is physically defective. A majority of the cases in which too many or too few organs are seen are to be imputed to incidental causes, which prevented nature from completing those portions, the absence or excess of which constitutes the essential characteristics of a species.

The figures of the muscles are various, some being round, others square, triangular, or flat like a ribbon. In length too, the variations are remarkable. Belonging to the vocal box, (the *larynx*,) the muscles, opening and closing the *rima glottidis*, to vary the strength of voice, are only about an eighth of an inch: the *sartorius*, or tailor's muscle, by which the legs are crossed, arises on the top of the hip bone, and extends six inches below the knee, passing two joints, being nearly three feet long.

Where are the muscles found? How many in the body? Are they ever in pain? Are muscles all alike, as it regards their shape and length? Are they of an uniform size? How long is any one muscle?

On the back, the *latissimus dorsi*, by which the hand is brought downward and backward, as by a blacksmith in using a hammer, is a foot broad on the back, scarcely an inch in width at its attachment to the arm, below the shoulder, but at least two feet in length.

All muscles are large in the middle, but small at the extremities: each one, too, is enveloped in a sheath, to keep it separate from a contiguous one, that the action may not interfere with the assigned office of any other. Indeed, each bundle of fibres of which the muscle is composed is secured in a sheath of its own, and the whole are finally incased in the outside tissue, that binds down and secures the whole.

These coverings of the muscles are elastic, stretching and recovering their original form when the contents are relaxed. When the greatest degree of contraction takes place, as in the muscles of the thigh, the power of the muscle is increased a hundred-fold by the tightness of the fascia. On the arm, for example, between the elbow and shoulder, the flexor of the fore-arm, in a state of action, produces a very prominent ball near the middle of the bone: on the inferior extremities, were the muscles to project out in such a manner, all symmetry would inevitably be sacrificed, and the power, too, would be very much abridged. Laborers bind a cord round the arm when they wish to exert an extraordinary degree of strength: sailors, in order to increase their muscular power, usually wear a tightly girded leather belt just above the hips; the principle of which is to bind down the bellies of the muscles more closely than the straps which nature has placed over them.

The muscles are divided into two classes, viz. the *voluntary*, and *involuntary;* the first are subservient to the will; but the second order is wholly beyond its influence. To put the voluntary muscles in action, we have only to will it; to incline the power to effect an orderly contraction. It is only necessary to will the bending of a finger, and it is done; to will the clinching of the hand, and the action follows instantly; to bend the leg, or extend the foot, and the command of the brain is obeyed.

Have the muscles coverings?
By what means is the strength of a muscle increased?
Why do laborers bind thongs round their arms in raising a weight?
Are any muscles beyond the control of the will?

On the other hand, the muscular fibres of the stomach are independent of the mind: the ear receives sonorous rays, and propagates them to the labyrinth, by the combined muscular apparatus within; nor can we prevent it by any effort of the mind to the contrary.

Before muscles become orderly, before they can serve the mind, they must be taught. Thus the child is obliged to totter round the room, receiving severe falls, before the muscles become trained to the business for which they were designed. The infant that has crept feels safer on its hands and knees than on its feet, because, by practice, the locomotive muscles obey the child in that position, and it is conscious of its security from its recollection of the fact.

When the child first endeavors to maintain an erect posture, its step is insecure, the muscles not having been associated to act in the new trial; the positive influence of mind, therefore, must not be suspended an instant; if it is, the infant falls to the floor.

When, therefore, any number of muscles have had practice in any particular mode or time, a habit is ultimately established, enabling them to continue the accustomed motion, without the watchful efforts of the mind. In this way we learn to walk, to articulate words, to rise, to sit, or assume a daily multitude of positions.

The principal difficulty the young musician has to encounter in learning to play an instrument consists in teaching the muscles of the fingers to move as rapidly as the notes are presented by the brain. Hence the long practice required before rapid execution is attained. By a long course of schooling the player can at length partially withdraw the mental superintendence; he can slumber, or abstract his thoughts from the air, or enter into conversation, but the fingers continue their unerring course, in time and with surprising accuracy.

The most opposite and apparently incongruous associations of muscular action are exhibited by rope-dancers, in throwing carving-knives, which fall in a perfect line, points downward, toward the crown of the head, while heavy brass rings are whirled with extreme rapidity in opposite directions, on each of the great toes. Such

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Why do infants creep before they walk?

Can the muscles be trained to a particular mode of action?

examples of the extraordinary feats that may be accomplished by teaching muscles to act differently from what they appear to have been expressly intended to act, are exceedingly common, but not the less surprising.

Two orders of muscles are obedient to their proper rulers; the one being under the express dominion of the mind, and the other influenced only by its appropriate stimulus. Food is the natural excitant of the muscular tissue of the stomach, and the blood, by its presence, stimulates the fibres of the heart.

But the most perplexing circumstance in relation to the muscles, is the property of contraction. Every muscle in the body is always tense; relaxation is a misapplied expression if it were understood that the rest of the muscle is like a rope slackened until it becomes pendulous between two points of attachment. However much a joint may be bent, the muscles always remain tense; apparently as much so as when actually put upon the stretch by the extension of the same joint. They carry their contraction still further in cases of luxations.

When the hip joint is dislocated, the muscles of the thigh, finding nothing to oppose them, shorten the limb by inches, and hold their grasp so tenaciously that pulleys are required to overcome their unrestrained activity.

When the joint has been too long neglected, and the head of the bone cannot be carried back to the socket, on account of the violent rigidity of the surrounding muscles, they invariably continue in that condition through life. Such a limb is consequently thicker than its fellow, the circumference being gained at the expense of its length.

Muscles are never weary; if that were possible, there would be examples of their inability to answer the requisitions of the will, from this cause. The mind's control over them may be suspended or even lost, but still they are always active, and always in a state of contraction. If their irritability were reduced by fatigue, it could not be recalled; the *vis insita*, the life of the muscle, survives the departure of the soul, and keeps it in a moderate contraction long after the vital temperature has been lost. Nothing short of putrefaction destroys its contractility.

Do the muscles act under the influence of stimuli?
Are the muscles ever relaxed?
Are they ever weary?
Does the contractility of the mustles remain after death?

Death, by which is meant the separation of the spiritual essence from the material body, does not destroy suddenly the life of the flesh, as that survives for days and even weeks. The truth of this position is established by the application of galvanism to the bodies of malefactors—the rolling eyeballs, the cramped limbs, the heaving chest, and in the fiendish expression of the muscles of the face.

An illustration of the permanency of this irritability may be seen also in the quivering of meat hung up in the shambles of the market; it is exhibited in the writhings of the eel deprived of its head and its skin; and in the violent snapping of the tortoise's jaws, many days after decapitation.

When we are perfectly exhausted, by reason of long continued fatigue, the muscles are not the sufferers; they then show their activity by violent exertions. Cramps, severe paroxysms, and painful contractions at such times supervene, and rarely at any other. These arise from the loss of the *nervous power*, which is the regulator of the system.

That power may be diminished by long continued exercise, by extreme watchfulness, or by many other causes. Yet while it is feeble the muscles contract, and permanent distortions ensue, if the nerves do not recover their energy. We retire to our beds, not to give the muscles an opportunity of reposing, but to recover nervous influence.

Every muscle has an antagonist, with a few exceptions. Where there is one to draw in one direction, there is an opponent to counteract; by this contrivance, a complete freedom of motion is given to the extremities. Each flexor has, opposed to it, an extensor; and the contraction of one is partially accomplished by the relaxation of the other; but the simultaneous action of both fixes the part on which they exert their power. Thus the flexors on the fore part of the neck, and their antagonists on the back side, maintain the head in a vertical line with the body.

Each muscle terminates in a hard, white cord, apparently the compressed threads constituting its volume, although such is not the fact. These are called *tendons*.

How can the power of the muscles be diminished?
Is there a superior power in the system to which the muscles are subservient?
What is the object of an antagonist muscle?
Describe a tendon.

At the place of origin the tendon is thin, inelastic, and short, soon intermingling itself with the substance of the muscle; but at the other end it assumes another form, being either round, or delicately smooth, tape-like and narrow. This is the part which passes over a joint to become attached to the next bone. Tendons are nearly insensible, being so far removed from the ordinary sensibility of every thing else, that they rarely participate in the diseases to which all the soft portions of the frame are subject.

To obviate friction, and prevent interference with its neighbors, each tendon is invariably conducted through a sheath, in which there is a copious secretion of a fluid, resembling oil, that keeps the cord soft, that it may glide easily.

Symmetry of form is wholly referable to the tendons. Without them, the exceeding bulk of the muscle would produce, according to our present notion of the beautiful, the most hideous deformities.

Were the muscles of the fore-arm carried to the palm, of the same size that they have at the elbow, the wrist would be of the diameter of the elbow; rendering the hand unwieldy and nearly useless.

To the free circulation of the blood into its inmost recesses the muscle is indebted for its vigor; and to the nerves for that sensitiveness which renders it susceptible of painful or pleasurable sensations.

The muscle possesses a sensibility completely beyond the control of any nerves in the body. An exhibition of this property—this disposition to recoil under excitement; to remove itself from the contact of foreign substances; in short, to preserve itself from the destructive agency of whatever has a tendency to exhaust its latent irritability—is within common reach. A demonstration of this phenomenon may be witnessed in the hearts of reptiles, pulsating by the prick of a pin, long after being removed from the animal; in the motion of the intestines of cats and dogs, cut into strips. While the vital temperature remains, they move like earth-worms, and when they have ceased to move, their irritability can be roused again by the application of stimuli.

How is friction prevented?
On what does the symmetry of the body depend?
On what does the vigor of the muscle mainly depend?

Here, then, is exemplified the existence of a property, purely vital, which never was, and in the instance before us could not be influenced by the nervous system.

Removed as this property is from the direct influence of the nerves, it becomes, under peculiar circumstances, the only hope. In cases of suspended animation, as in drowning, swooning, &c., there is a prostration of the nervous system; it cannot act; the will cannot produce an impression on the muscles, because its messengers, the nerves, are no longer in a condition, from some unknown cause, to transmit the orders. At this juncture, if no saving efforts are made, the individual dies. But a skilful application of agents to the muscles raises their tone to that high degree of excitability, that they actually resuscitate the expiring spirit of the nerves. The instant that is effected, the sign of success is manifested by the obedience of the muscles; the sufferer moves a limb, because he determines it; order is at the same instant restored in the nerves, and the individual is restored to life.

How exceedingly complicated is the machinery of our bodies! On a cursory examination only of the anatomy of the human frame, the beautiful arrangement of such a multitude of tubes, valves, cords, threads and bones, all harmonizing and perfect in their action, is well calculated to excite astonishment.

Here are two hundred and forty-six distinct bones, most beautifully articulated one with another; and to move them, there is attached to them four hundred and forty-six muscles, so systematically, carefully and economically applied to the levers, that no power is unnecessarily sacrificed, and perfect symmetry of form is secured. Each muscle, at the least calculation, has ten thousand intentions. All of them are ready every moment of time to perform their appropriate functions.

In the simple act of breathing, whether we are in motion or resting, sleeping or awake, full one hundred of these never weary muscles are brought into motion. They are required to labor incessantly from the first instant of birth to the latest period of existence, on an average of twenty inspirations and alternate expirations

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Through what organs is suspended animation and consciousness recalled?

every minute of time; yet they never refuse their concurrence in this indispensable vital action.

The heart, itself a compound muscle, whose principle of mechanism is but imperfectly understood, exerts its muscular force unremittingly till death, in propelling the blood into the arteries sixty times a minute.

The stomach and muscles of the digestive organs, together with those of the abdomen, are equally remarkable for their untiring activity and perfect readiness to perform their appropriate offices.

Before one of our senses, even that of smell, the lowest, and apparently of little utility, when compared with the organs of hearing and seeing, can operate, it must be intimately united with an almost countless multitude of vessels, nerves, glands and muscular tissues.

A CATALOGUE OF THE PRINCIPAL MUSCLES.

Perhaps it may be thought that the following table is not only unnecessarily minute, but altogether too technical; but as we could devise no method of rendering it much more simple, without making the whole unintelligible, the scientific names of the *points* of *origin* and *insertion* have been preserved. It is not expected that children will either be interested in or required to learn this intricate division of anatomy, even should the first principles of the science be generally taught in common schools.

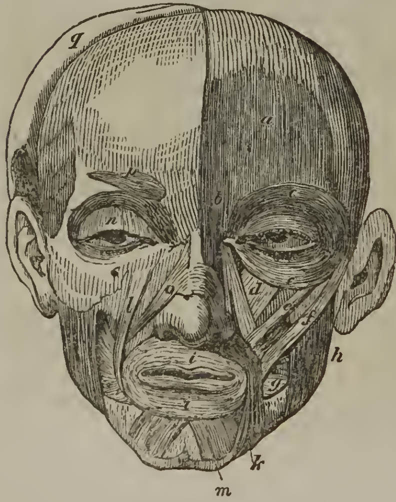
For instructers, however, drawing-school pupils, and young artists, the few technical words which are retained will be of consequence, as they will be able to refer to the skeleton (which we also hope will be considered, at no very remote period, an indispensable part of school apparatus) for the exact places to which they refer.

NOTE.—Where the muscle has no fellow, it is marked thus.* It should be recollected that the muscles of one side of the body only are here considered.

MUSCLES OF THE HEAD, EYELIDS, EYEBALL, NOSE AND MOUTH.

Name.	*Arises from*
Occipito-frontalis.*	The upper ridge of the occipital bone; its aponeurosis covers the upper part of the head.
Corrugator supercilii.	Above the root of the nose.
Orbicularis palpebrarum.	Around the edge of the orbit.
Levator palpebræ superioris.	The bottom of the orbit near the optic foramen.
Rectus superior. Rectus inferior. Rectus internus. Rectus externus.	Around the optic foramen of the sphænoid bone, at the bottom of the orbit.
Obliquus superior, or Trochlearis.	Near the optic foramen, and passes through a loop in the internal canthus of the eye, and is reflected to be
Obliquus inferior.	The ductus nasalis, and is inserted

Fig. 31.



Explanation of Fig. 31.

a, the *pyramidalis nasi;* o, the *compressor nasi;* a, *occipito frontalis;* c, *orbicularis palpebrarum;* p, *corrugator supercilii;* n, *levator palpebræ superioris;* f, *zygomaticus major;* e, *zygomaticus minor;* i, *orbicularis oris;* k, *depressor anguli oris;* m, *depressor labii inferioris;* h, the *masseter* muscle; g, the *buccinator;* d, *levator labii superioris alæque nasi;* g, the *parietal bone* seen beyond the coronal suture.

MUSCLES OF THE HEAD, EYELIDS, EYEBALL, NOSE AND MOUTH.

Inserted into	*Use.*
The skin of the eyebrows and root of the nose.	To pull the skin of the head backward—raise the eyebrows and skin of the forehead.
The inner part of the occipito-frontalis.	To wrinkle the eyebrows.
The inner corner of the eyes.	To shut the eye.
The cartilage of the tarsus of the upper eyelid.	To open the eye, by raising the upper eyelid.
The anterior part of the tunica sclerotica, opposite to each other.	To raise it upward.
	To pull it downward.
	To turn it to the nose.
	To move it outward.
The posterior part of the bulb, between the rectus and the entrance of the optic nerve.	To roll the eye, and turn the pupil downward and outward.
Opposite to the former.	To roll the eye.

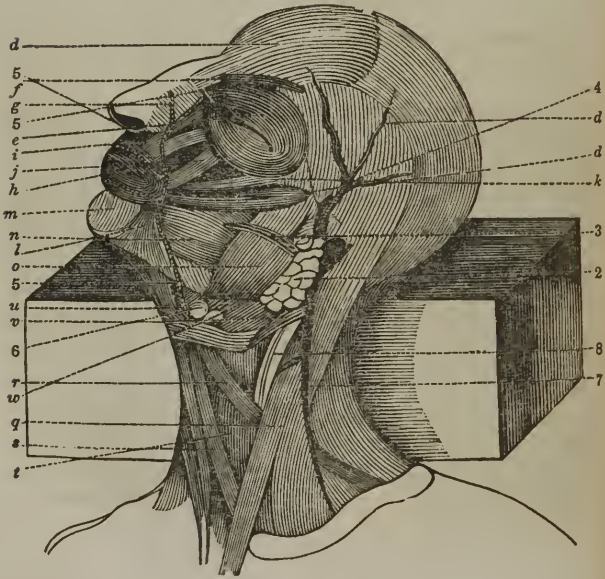
By recurring to the plate, (Fig. 31,) the pupil will form a tolerably accurate idea of the muscles of the face. They lie very superficially, just under the skin, and are all muscles of expression; therefore only perfectly developed in the European, or white man's face, in whose countenance the passions of the mind are strongly exhibited. In the negro, owing partly to the color of the skin, the expression is necessarily very imperfect: he can never have majesty nor dignity, or an elevation of thought, portrayed in his features. When the jet black negro expresses his emotions, unless the teeth and the whites of the eyes are exposed, there is little variety of expression, because no shades are created by the contractions of the muscles. This fact is familiar to the engraver and the painter. The pictures of colored persons are always very nearly alike; the portrait of one will answer for many; and the circumstance is wholly referable to the imperfect manner in which the light and shadows are created on the skin.

The muscles of expression are fewer and smaller, as animals descend the scale of creation.

Name some of the principal muscles of expression in the face.
Give the names and office of those about the eye.
Are the muscles of expression different in the lower animals?
Why are the portraits of colored people wanting in expression?

Name.	*Arises from.*
Levator labii superioris alæque nasi.	The nasal process of the superior maxillary bone.
Levator labii superioris proprius.	The upper jaw under the orbit.
Levator anguli oris.	The orbitar foramen of the sup. max. bone.
Zygomaticus major.	The os jugale, near the zygomatic suture, and runs downward.
Zygomaticus minor.	Above the zygomaticus major.
Buccinator.	The sockets of the last molares, and the coronal process of the lower jaw.
Depressor anguli oris.	The lower edge of the under jaw, near the chin.
Depressor labii inferioris.	The inferior part of the lower jaw, next the chin.

Fig. 32.



Inserted into	*Use.*
The upper lip and ala of the nose.	It raises the upper lip, and dilates the nostrils.
The middle of the upper lip.	To pull the upper lip directly upward.
The orbicularis, at the angle of the mouth.	To raise the corner of the mouth.
The angle of the mouth, with the depressor of the lip.	To inflate the cheek and raise the angle of the mouth.
The angle of the mouth.	To raise the angle of the mouth outward.
The angle of the mouth, and is perforated by the duct of the parotid gland.	To contract the mouth and draw the angle of it outward and backward.
The angle of the mouth.	To draw the corner of the mouth downward.
The middle of the under lip.	To draw the under lip downward and outward.

Explanation of Fig. 32.

d. The occipito-frontalis.
e. The orbicularis palpebrarum.
f. The corrugator supercilii.
g. The compressor naris.
h. The orbicularis oris.
i. The levator labii superioris alæque nasi.
j. The levator anguli oris.
k. The zygomaticus major and minor.
l. The depressor anguli oris.
m. The depressor labii inferioris.
n. The buccinator.
o. The masseter.
p. The temporal fascia, or aponeurosis.
2. The parotid gland, which supplies the mouth with saliva.
3. Steno's duct, to conduct the fluid into the mouth.
4. The temporal artery.
5. The facial artery.

Parts seen in the neck.

q. The sterno-cleido mastoideus.
r. The omo-hyoideus.
s. The sterno-hyoideus.
t. The sterno-thyroideus.
u. The digastricus.
v. The stylo-hyoideus.
w. The mylo-hyoideus.
6. The sub-maxillary gland; also pours saliva into the mouth.
7. The external jugular vein.
The sheath containing the carotid artery.

Name.	*Arises from*
Orbicularis oris.*	This muscle surrounds the lips, and is in a great measure formed by the buccinator, zygomatici, and others, which move the lip.
Depressor labii superioris alæque nasi.	The sockets of the upper incisor teeth.
Constrictor nasi.	The root of one wing of the nose, and
Levator menti vel labii inferioris.	The lower jaw, at the root of the incisors.

MUSCLES OF THE EXTERNAL EAR.

Superior auris, or attollens aurem.	The tendon of the occipito-frontalis above the ear.
Anterior auris.	Near the back part of the zygoma.
Posterior auris, or retrahens auris.	The mastoid process, by two and sometimes three fasciculi.
Helicis major.	The upper, anterior, and acute part of the helix.
Helicis minor.	The interior and anterior part of the helix.
Tragicus.	The outer and middle part of the concha, near the tragus.
Antitragus	From the root of the inner part of the helix.
Transversus auris.	The upper part of the concha.

MUSCLES OF THE INTERNAL EAR.

Laxator tympani.	The spinous process of the sphænoid bone.
Tensor tympani.	The cartilaginous extremity of the Eustachian tube.
Stapedius.	A little cavern in the petrous portion, near the cells of the mastoid process.

Inserted into	*Use.*
	To shut the mouth, by contracting the lips.
The root of the ala nasi and upper lip.	To pull the ali nasi and upper lip down.
goes across to the other.	To compress the wings of the nose.
The skin in the centre of the chin.	To raise the under lip and skin of the chin.

MUSCLES OF THE EXTERNAL EAR.

The root of the cartilaginous tube of the ear.	To draw the ear upward, and make it tense.
The eminence behind the helix.	To raise this eminence forward.
The septum that divides the scapha and concha.	To draw the ear back, and stretch the concha.
The cartilage of the helix, a little above the tragus.	To depress the upper part of the helix.
The crus of the helix.	To contract the fissure.
The upper part of the tragus.	To depress the concha, and pull the tragus a little outward.
The upper part of the antitragus.	To dilate the mouth of the concha.
The inner part of the helix.	To draw these parts toward each other.

MUSCLES OF THE INTERNAL EAR.

The long process of the malleus.	To draw the malleus obliquely forward, toward its origin.
The handle of the malleus.	To pull the malleus and membrane of the tympanum toward the petrous portion.
The posterior part of the head of the stapes.	To draw the stapes obliquely upward toward the cavern.

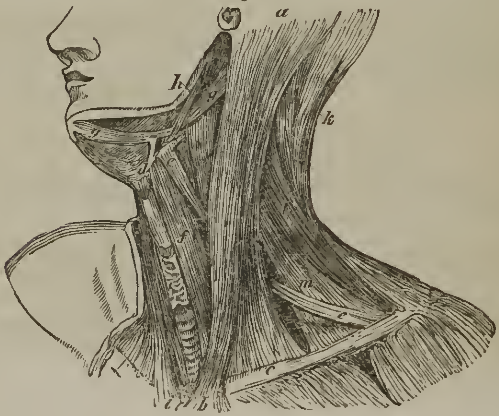
MUSCLES OF THE LOWER JAW.

Name.	*Arises from*
Temporalis.	The lower part of the parietal bone and os frontis; squamous part of the temporal bone; back part of the os jugale; the temporal process of the sphænoid bone, and the aponeurosis which covers it.
Masseter.	The sup. max. bone, near the os jugale; and from the anterior part of the zygoma.
Pterygoideus internus.	The internal pterygoid process of the sphænoid bone.
Pterygoideus externus.	The external pterygoid process.

MUSCLES ABOUT THE NECK.

Platysma myoides.	The cellular membrane covering the pectoral and deltoid muscles.
Sterno-cleido-mastoideus.	The upper part of the sternum, and fore part of the clavicle.

Fig. 33.



MUSCLES OF THE LOWER JAW.

Inserted into	*Use.*
The coronoid process of the lower jaw, its fibres being bundled together and pressed into a small compass, so as to pass under the jugum, or zygoma.	To move the lower jaw upward.
The angle of the lower jaw upwards to the basis of the coronoid process.	To raise and move the jaw a little forward and backward.
The lower jaw on its inner side, and near its angle.	To raise the lower jaw, and draw it a little to one side.
The condyloid process of the lower jaw and capsular ligament.	To move the jaw, and to prevent the ligament of the jaw from being pinched.

MUSCLES ABOUT THE NECK.

The side of the chin and integuments of the cheek.	To draw the cheeks and skin of the face downward.
The mastoid process, and as far back as the occipital suture.	To move the head to one side and bend it forward.

Explanation of Fig. 33.

A, and b, sterno cleido mastoideus; h, stylo hyoideus; g, g, the two bellies of the *digastricus; f, sterno hyoideus; i,* the lower end of the *mastoideus* of the right side; *e, omo hyoideus; d,* the os *hyoides; c,* the *clavicle; k, complexus.*

Under the sterno cleido mastoid muscle, bounded by the letters *a* and *b*, in the opposite drawing, are a variety of beautiful, ribbon-like muscles, which are generally attached to the bone of the tongue, and the vocal box, called the *larynx*, which is the protuberance in the front part of the throat. Again, those muscles which arise about the base of the skull, under the ear, and angle of the under jaw, are also inserted into the same places; so that the bone and larynx are movable fulcrums, increasing the power of the muscles on either side, by changing their position. By this simple contrivance, the contraction of the muscles compresses the windpipe, and thus increases or varies the tone of the voice, by diminishing the diameter of the air tube. Thus, bad singers in sounding a high note stretch back the head; thus, too, unconsciously press the musical pipe into the smallest diameter. To sound a bass note, the chin is brought towards the breast,—and the same muscles are relaxed, and the diameter of the tube is at once increased.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND BONE OF THE TONGUE.

Name.	Arises from
Digastricus.	A fossa at the root of the mastoid process.
Mylo-hyoideus.	The inner surface of the jaw bone.
Genio-hyoideus.	The inside of the chin.
Genio-glossus.	The inside of the chin.
Hyo-glossus.	The horn, basis, and cartilage of the os hyoides.
Lingualis.	The root of the tongue laterally.

MUSCLES SITUATED BETWEEN THE OS HYOIDES AND TRUNK.

Sterno-hyoideus.	The sternum and clavicle.
Omo-hyoideus.	Near the coracoid process of the scapula.
Sterno-thyroideus.	The upper and inner part of the sternum.
Thyreo-hyoideus, or Hyo-thyroideus.	Part of the basis and horn of the os hyoides.
Crico-thyroideus.	The side of the cricoid cartilage.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND OS HYOIDES, LATERALLY.

Stylo-glossus.	The apex of the styloid process.
Stylo-hyoideus.	The basis, and about the middle of the styloid process.
Stylo-pharyngeus.	The root of the styloid process.
Circumflexus, or Tensor palati.	Near the Eustachian tube, and passes through the hamulus of the pterygoid process, to be
Levator palati mollis.	The point of the os petrosum, the Eustachian tube, and sphænoid bone.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND BONE OF THE TONGUE.

Inserted into	*Use.*
The lower and anterior part of the chin.	To draw the lower jaw downward.
The basis of the os hyoides.	To move the os hyoides upward.
The basis of the os hyoides.	To move the os hyoides upward.
The tongue, forming part of its substance.	To move the tongue in various directions.
Into the tongue laterally.	To draw the tongue downward and inward.
The extremity of the tongue.	To shorten and draw the tongue backward.

MUSCLES SITUATED BETWEEN THE OS HYOIDES AND TRUNK.

The basis of the os hyoides.	To draw the os hyoides downward.
The basis of the os hyoides.	To draw the os hyoides downward.
The thyroid cartilage.	To pull the thyroid cartilage downward.
The side of the thyroid cartilage.	To raise the cartilage, and depress the bone.
The inferior horn of the thyroid cartilage.	To pull the thyroid cartilage towards the cricoid.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND OS HYOIDES, LATERALLY.

The side of the root of the tongue.	To pull the tongue backward.
The basis of the os hyoides.	To draw the os hyoides upward.
The edge of the pharynx, and back of the thyroid cartilage.	To dilate the pharynx, and raise the cartilage.
The velum pendulum palati.	To draw the velum pendulum palati obliquely downward, and stretch it.
The velum pendulum palati, being expanded upon it.	To pull the velum pendulum backward and upward.

MUSCLES SITUATED ABOUT THE ENTRY OF THE FAUCES.

Name.	*Arises from*
Constrictor faucium.	Near the root of the tongue on each side, and goes round to be
Palato-Pharyngeus.	The middle of the soft palate, goes round the entry of the fauces, the tendon of the circumflexus palati, and velum pendulum palati, to be
Azygos uvulæ.*	The commissure of the ossa palati.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE PHARYNX.

Constrictor pharyngius inferior.	The cricoid and thyroid cartilages.
Constrictor pharyngius medius.	The horns, and appendix of the os hyoides.
Constrictor pharyngius superior.	The pterygoid process, the lower jaw, and the cuneiform process of the os occipitis.

MUSCLES SITUATED ABOUT THE GLOTTIS.

Crico-arytænoideus posticus.	The cricoid cartilage posteriorly.
Crico-arytænoideus lateralis, or obliquus.	The side of the cricoid cartilage.
Thyreo-arytænoideus.	The back of the thyroid cartilage.
Arytænoideus obliquus.*	The root of one arytænoid cartilage.
Arytænoideus transversus.*	One of the arytænoid cartilages.
Thyreo-epiglottideus.	The thyroid cartilage.
Arytæno epiglottideus.	The upper part of the arytænoid cartilage laterally.

MUSCLES SITUATED ABOUT THE ENTRY OF THE FAUCES.

Inserted into	*Use.*
The middle of the velum pendulum palati, near the uvula.	To raise the tongue, and draw the velum toward it.
The upper and posterior part of the thyroid cartilage.	To contract the arch of the fauces.
The extremity of the uvula.	To shorten and raise the uvula.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE PHARYNX.

The middle of the pharynx.	To compress part of the pharynx.
The ambit of the pharynx.	To compress the pharynx, and draw the os hyoides upward.
The middle of the pharynx.	To move the pharynx upward and forward, and to compress its upper part.

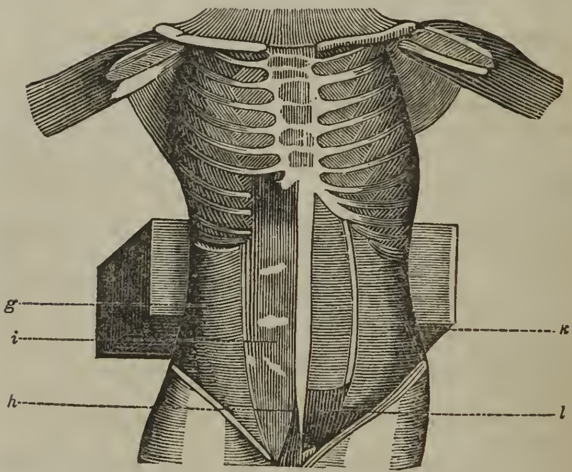
MUSCLES SITUATED ABOUT THE GLOTTIS.

The back of the arytænoid cartilage.	To open the glottis.
The side of the arytænoid cartilage.	To open the glottis.
The fore part of the arytænoid cartilage.	To draw the arytænoid cartilage forward.
The extremity of the other.	To draw them toward each other.
The other arytænoid cartilage.	To shut the glottis.
The side of the epiglottis.	To pull the epiglottis obliquely downward.
The side of the epiglottis.	To move the epiglottis outward.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE ABDOMEN.

Name.	*Arises from*
Obliquus descendens externus.	The lower edges of the eight inferior ribs near the cartilages.
Obliquus ascendens internus.	The spinous processes of the three last lumbar vertebræ, back of the sacrum, and spine of the ilium.

Fig. 34.



Transversalis abdominis.	The cartilages of the seven lower ribs, and the transverse processes of the four lower lumbar vertebræ and spine of the ilium.
Rectus abdominis.	The outside of the sternum and xyphoid cartilage.
Pyramidalis.	The anterior upper part of the pubis.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE ABDOMEN.

Inserted into	*Use.*
The linea alba, ossa pubis, and spine of the ilium.	To compress the abdomen.
The cartilages of all the false ribs, linea alba, and pubis, and sternum, by a flat tendon.	To compress the abdomen.

Explanation of Fig. 34.

g, The obliquus internus, with its tendon divided, to show
h, The pyramidalis.
i, The rectus abdominis. Beneath the internal oblique there is situated
k, The transversalis abdominalis, and
l, The fascia transversalis.

The tendons of the abdominal muscles form junctions in front, where their broad white tendons meet, which are denominated *lines;* and that which runs exactly in the middle, from the lower point of the sternum to the pubis, is the *linea alba*, or white line. Again, the long abdominal muscles, lying each side of this linea alba, are intersected, several times, between their two extremities, by similar tendinous lines, which, in reality, divides them into a chain of muscles. This structure has reference to increasing their power, by a series of contractions, along their course, which thereby answers a second intention, viz. preserving a symmetry of form. By consulting Fig. 34, page 70, both the vertical and transverse lines are discoverable. Statues representing action invariably exhibit the muscles of the bowels thrown into ridges. Upon the principles adverted to in the preliminary essay on myology, without these transverse bands the bellies of the long recti muscles, in order to pull the chest, as in stooping, for example, while seated in a chair, so as to bring the breast down to the knees, would have a bulk, by the process of contraction, equal to a two-quart measure. By the introduction of the transverse tendinous lines, two vastly important results are obtained,—increased power and beauty of form.

The linea alba throughout its whole length, and into the ensiform cartilage.	To compress the abdominal viscera.
The side of the symphysis of the pubis.	To compress the abdomen, and bend the trunk.
The linea alba, below the umbilicus.	To assist the lower portion of the rectus.

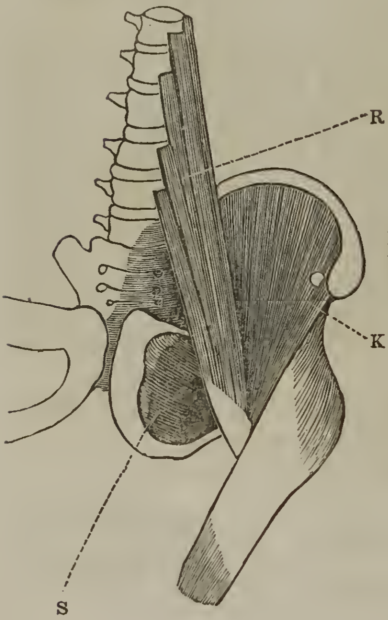
MUSCLES SITUATED WITHIN THE PELVIS.

Name.	*Arises from*
Obturator internus.	The foramen ovale, obturator ligament, ilium, ischium, and pubis.
Coccygeus.	The spinous process of the ischium.

MUSCLES SITUATED WITHIN THE CAVITY OF THE ABDOMEN.

Quadratus lumborum.	The posterior part of the spine of the ilium.
Psoas parvus.	The transverse process of the last dorsal vertebræ.

Fig. 35



Explanation of Fig. 35.
K. The iliacus internus.
R. The psoas magnus.
S. The obturator externus.

MUSCLES SITUATED WITHIN THE PELVIS.

Inserted into	*Use.*
A large pit between the trochanters of the femur.	To roll the femur obliquely outward.
The extremity of the sacrum and os coccygis.	To move the coccyx forward and inward.

MUSCLES SITUATED WITHIN THE CAVITY OF THE ABDOMEN.

The transverse apophyses of the loins and last spurious rib.	To support the spine and draw it to one side.
The brim of the pelvis, near the place of the acetabulum.	To bend the loins forward.

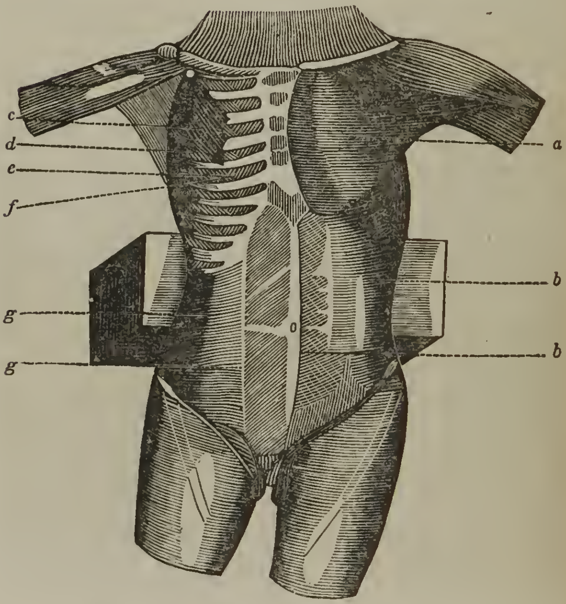
On the inside of the broad hip bone, *os innominatum*, seen on the opposite page, Fig. 35, and also running up by the side of the lumbar vertebræ, three muscles have their origin, that bear a highly important part in the locomotive power of the body. In these, as in every other place in the system, a twofold intention is answered. First, these three muscles are cushions, on which the coils of the intestines rest. Without them, some other provision would have been necessary, as a soft bed is indispensable for them, in the violent exercises of running, leaping, or even walking. Secondly, the tendons of the *psoas magnus* and *iliacus internus* are sent over the brim of the pelvis, to wind down the inside of the groin, close to the bone, to reach the backside of the thigh bone, where they are fastened. Obscure as they are, these muscles, when standing on our feet, maintain the body in an erect position. If we desire to move forward, these muscles lift up the whole limb, and when they relax, the foot strikes the ground again. If, while sitting, the knee is raised towards the chest, the act is accomplished by these two muscles. In walking and running, therefore, as they are the *lifters* of the leg, their services could not be dispensed with. A *lumbar abscess*, a painful disease, wholly forbidding the movement of the limb of the side in which it occurs, is a collection of matter under the *psoas magnus*, and next to the back bone, near the line R, on the plate. As the abscess cannot be very safely discharged by a surgical operation, through the muscles of the back, in protracted cases, the matter sometimes follows the muscles quite into the limb, and forces its way down, even to the knee, before it escapes. This dreadful disease has been induced by lying on the damp ground, after freely exercising; and by unnecessary feats of strength, in lifting burdens.

Name.	*Arises from*
Psoas magnus.	The bodies and processes of the last dorsal and all the lumbar vertebræ.
Iliacus internus.	The internal surface of the spine of the ilium.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE THORAX.

Pectoralis major.	The clavicle, sternum and seven true ribs.

Fig. 36.



Subclavius.	The cartilage of the first rib.
Pectoralis minor.	The third, fourth, and fifth ribs.

Inserted into	*Use.*
The os femoris, a little below the trochanter minor.	To bend the thigh forward.
The femur in common with the psoas magnus.	To assist the psoas magnus.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE THORAX.

The upper and inner part of the humerus.	To draw the arm forward, or obliquely forward.

Explanation of Fig. 36.

a, The pectoralis major.
b, *b*, The obliquus abdominis externus descendens: beneath these muscles the following :—
c, The pectoralis minor.
d, The serratus magnus anticus.
e, The external intercostal muscles.
f, The internal intercostal muscles.
g, The obliquus abdominal internus ascendens.

By returning to the anatomy of the ribs, it is there shown that they are constructed to move: breathing is effected by increasing and diminishing the capacity of the chest, as the lungs are inflated or collapsed. To carry on this operation, an appropriate class of muscles take their rise, on and about the ribs and sternum, to be exclusively engaged in this respitory action. Between the edges of the ribs short oblique muscles, one the *internal* and the other the *external*, crossing each other, like suspenders on a man's back, are untiring in their labors; when they contract, the ribs are brought together; and when relaxed, the diameter of the chest is enlarged. All the muscles on the breast and sides are remotely respitory agents. If the arms are fixed, by their contraction the ribs are drawn outwardly. Asthmatic persons, because the small intercostal muscles do not relax enough, bring the pectoral muscles to their aid, by raising their hands and holding on to a door, or a beam, for example, above the head. This enables them to pull open, as it were, the bottom of the chest. Women often swoon and sometimes drop down dead instantly, in consequence of lacing the chest so tightly that the ribs cannot possibly move.

The under surface of the clavicle.	To move the clavicle downward.
The coracoid process of the scapula.	To roll the scapula.

Name.	*Arises from*
Serratus major anticus.	The eight superior ribs.

MUSCLES SITUATED BETWEEN THE RIBS AND WITHIN THE THORAX.

Intercostales externi.	The lower edge of each upper rib.
Intercostales interni.	Like the former, their fibres are directed from behind forward.
Triangularis, or Sterno-costalis.	The middle and inferior part of the sternum.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE NECK, CLOSE TO THE VERTEBRÆ.

Longus colli.	The bodies of the three upper dorsal and transverse processes of the four last cervical.
Rectus internus capitis major.	The transverse processes of the five last cervical vertebræ.
Rectus internus capitis minor.	The fore part of the atlas.
Rectus capitis lateralis.	The transverse process of the atlas.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE TRUNK.

Trapezius, or Cucullaris.	The os occipitis and the spinous processes of all the vertebræ of the neck and back.
Latissimus dorsi.	The spine of the ilium, spinous process of the sacrum, lumbar and inferior dorsal vertebræ; adheres to the scapula and inferior false ribs.
Serratus posticus inferior.	The spinous processes of the two last dorsal and three lumbar vertebræ.

Inserted into	*Use.*
The base of the scapula.	To bring the scapula forward.

MUSCLES SITUATED BETWEEN THE RIBS AND WITHIN THE THORAX.

The superior edge of each lower rib.	To elevate the ribs.
The cartilages of the five last true ribs.	To depress the cartilages of the ribs.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE NECK, CLOSE TO THE VERTEBRÆ.

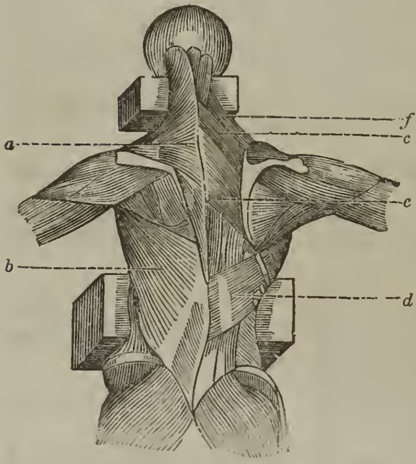
The anterior tubercle of the dentatus.	To pull the neck to one side.
The cuneiform process of the os occipitis.	To bend the head forward.
The os occipitis, near the condyloid process.	To assist the former.
The os occipitis, near the mastoid process.	To move the head to one side.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE TRUNK.

The clavicle, part of the acromion, and the spine of the scapula.	To move the scapula, bend the neck, and pull the head backward.
The os humeri, between its two tuberosities in the edge of the groove for the tendon of the biceps muscle.	To draw the os humeri backward, and to roll it upon its axis.
The lower edge of the three or four lowermost ribs, near their cartilages.	To draw the ribs outward, downward, and backward.

Name.	*Arises from*
Rhomboideus.	The spinous processes of the three last cervical, and four first dorsal vertebræ.
Splenius.	The spines of the four last cervical, and four superior dorsal vertebræ.
Serratus superior posticus.	The spinous processes of the three last cervical, and two superior dorsal vertebræ.
Spinalis dorsi.	Two spinous processes of the loins, and three lower of the back.
Levatores costarum, or Supra-cosales.	The transverse processes of the last cervical and the dorsal vertebræ.
Sacro-lumbalis.	The sacrum, spine of the ilium, and the spinous and transverse processes of the lumbar vertebræ.

Fig. 37.



Explanations of Fig. 37.

a, The trapezius.
b, The latissimus dorsi.
c, The rhomboideus minor.
d, The rhomboideus major.
e, The serratus posticus inferior.
f, The levator anguli scapulæ.

Blocks were introduced to represent the figure in a horizontal position, that the muscles might be more distinctly seen.

Inserted into	*Use.*
The basis of the scapula, at its upper and lower part.	To move the scapula upwards and backward.
The two first cervical vertebræ, and the side of the os occipitis.	To move the head backward, and also to one side.
The second, third, and fourth ribs, by three neat fleshy tongues.	To expand the thorax, by elevating the ribs.
All the spinous processes of the back, except the first.	To extend the vertebræ.
The angles of the ribs.	To lift the ribs upward.
The lower edge of each rib, by a flat tendon.	To draw the ribs downward, to move the body upon its axis, to assist the longissimus dorsi, and to turn the neck back, or to one side.

All the muscles of the back, clearly defined in Fig. 37, on the opposite page, are broad, thin, and generally produce the slow motion of the limbs. In the middle of the *trapezius*, marked *a*, is a white line, where the fibres of the muscles on either side meet and adhere to the spinous processes of the bones of the neck. On this line, in quadrupeds, is placed a powerfully strong cord, by the farriers called *paxwax*, but by anatomists *ligamentum nuchæ*, which, being attached to the back bone, between the shoulders, prevents their heavy head from drooping to the ground. It will not relax: when they drink or feed on a level with their feet, the nose, even by a voluntary effort, barely reaches to the earth.

Examples of the prodigious strength of this ligament or nape of the neck are noticeable in the elephant, rhinoceros, sea-horse, and wild boar. It becomes exceedingly strong in the necks of oxen habituated to draw burdens by their horns instead of a bow about the shoulders. When divided artificially, in any of the quadrupeds, the muscles cannot possibly maintain the head in its natural position.

Fig. 38.

Explanation of Fig. 38.

a, upper portion of the *trapezius; i*, *sterno cleido mastoideus; d*, the *deltoid* portion of the *trapezius; f*, the *latissimus dorsi; n*, *n*, *n*, *n*, portions of the latissimus, rising by digitations from the ribs; *g*, and *b*, tendinous eontinuation of the latissimus into fibres of the gluteus maximus; *h*, the deltoides musele, to raise the arm; *k*, *e*, *m*, the infra spinatus, belonging to the shoulder; *c*, the clavicular portion of the deltoides; *l*, the intermingling of the fibres of the gluteus maximus and latissimus dorsi.

The artist was particularly fortunate in delineating the museles in the aeeompanying diagram. No plate could more aceurately show the relation which one bears to the other, nor more truly represent the converging fibres, all ecntring in the tendons. As in the demonstration of the eye, it can also be said herc, that there are coats of museles on the back and sides. One overlaps the edges of another, in such a perfeet manner as to leave no deep spaces: an even eovering is thus spread over the skeleton. The *latissimus dorsi*, marked *f*, is one of the most beautiful in the body; and its utility is proved every moment. Its offiee is to bring down the hand. Before man invented instruments which have superseded, to eonsiderable cxtent, the primitive use of the hand in some partieulars, his fist was a mallet, the arm the handle, and this muscle the power that gave force to the blow. Those mechanics who are eonstantly using hammers and axes inerease its size and strength amazingly. If the arm, on the other hand, be firmly fixed, in a horizontal position, the digitations marked *n*, *n*, *n*, *n*, by their strong hold upon the false ribs, would open the bottom of the chest quite effectually. Over the shoulder joint, and from thence running to the middle of the arm bone, is a splendid musele,—the *deltoides*, marked *h*, which raises the arm to a level with the shoulder; its lateral portions even earry the elbow very mueh above the level of their origin. If it were divided, no remaining muscle eould perform its offiee. Just above *f*, winding partially under the deltoides, is that musele whieh extends the arm. The name of *triceps extensor cubiti* is given it, because it arises by three heads, whieh uniting in one tendon, passes the elbow joint, on the back of the arm, to be inserted into the *ulna*, or, as the bone is sometimes called, the *cubit*. Lastly, *k*, *e*, *m*, direets the eye to the *infra spinatus*, arising on the external surface of the shoulder-blade, and inserted into the arm bone. By its eontraction the arm is raised a very little, and earried backward; its tendon, as it passes over the shoulder joint, adheres to the capsular ligament and keeps it drawn out, so that it may not be pinched by the rolling motion of the ball in the socket.

A provision analogous to this double offiee of the trieeps tendon over the back of the elbow exists in the knee, ankle, and several other joints. Owing to the little elastieity of the capsular membrane, there is a tendeney, in eonsequence of the pressure of the tendons running over the articulation, to force them into the cavity made by bending the joint, where they would inevitably suffer violenee when the ends of the bones eame into plaec again, were there not a meehanieal contrivance to prevent it. As soon as the flexors begin to act, some other muscles or parts of muscles at the same instant also begin to pull the surrounding ligament out from the depression: thus it is kept from being pinehed and ultimately ruined by the injury it would sustain.

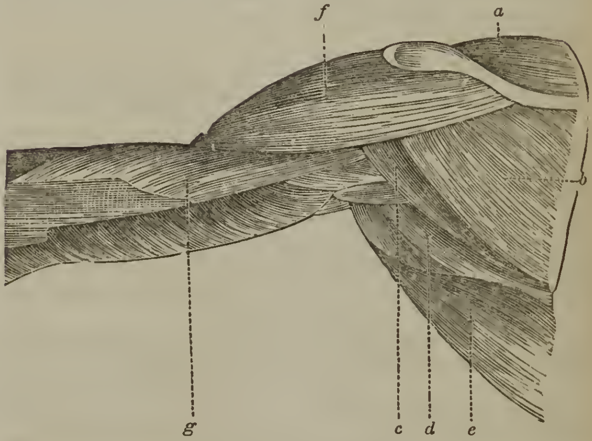
Name.	*Arises from*
Longissimus dorsi.	The same parts as the former, and by one common broad tendon.
Complexus.	The transverse processes of the four inferior cervical, and seven superior dorsal vertebræ.
Trachelo-mastoideus.	The transverse processes of the five lower cervical and three upper dorsal vertebræ.
Levator scapulæ.	The transverse processes of the four superior cervical vertebræ.
Semi-spinalis dorsi.	The transverse processes of the 7th, 8th, 9th, and 10th dorsal vertebræ.
Multifidus spinæ.	The sacrum, ilium, oblique and transverse processes of the lumbar, the transverse of the dorsal, and four cervical vertebræ.
Semi-spinalis colli, or Spinalis cervicis.	The transverse processes of the six upper dorsal vertebræ.
Transversalis colli.	The transverse processes of the five upper dorsal vertebræ.
Rectus capitis posticus major.	The transverse process of the second cervical vertebræ.
Rectus capitis posticus minor.	The first vertebræ of the neck.
Obliquus capitis superior.	The transverse process of the atlas.
Obliquus capitis inferior.	The spinous process of the dentatus.
Scalenus	The upper surface of the first and second rib.
Interspinales.	Between the spinous processes of the six inferior cervical vertebræ.
Inter-transversales.	Between the transverse processes of the vertebræ.

Inserted into	*Use.*
The transverse processes of all the dorsal and one cervical vertebra.	To stretch the vertebræ of the back, and keep the trunk erect.
The middle of the os occipitis, at its tubercle.	To draw the head backward.
The os occipitis, behind the mastoid process of the temporal bone.	To draw the head backward.
The upper angle of the scapula.	To move the scapula forward and upward.
The spinous processes of the four superior dorsal and the last cervical vertebræ.	To extend the spine obliquely backward.
The spinous processes of the lumbar, dorsal, and cervical vertebræ, except the atlas.	To extend the back, and draw it backward, or to one side, and prevent the spine from being too much bent forward.
The spinous processes of the five middle cervical.	To stretch the neck obliquely backward.
The transverse processes of the cervical vertebræ.	To turn the neck obliquely backward, and to one side.
The lower ridge of the os occipitis.	To extend the head, and draw it backward.
The os occipitis at its tubercle.	To assist the *rectus* major.
The end of the lower occipital ridge.	To draw the head backward.
The transverse process of the atlas.	To draw the face to one side.
The transverse processes of the cervical vertebræ.	To move the neck forward, or to one side.
The spinous processes of the vertebræ above.	To draw the spinous processes towards each other.
The transverse processes of the vertebræ above.	To draw the transverse processes towards each other.

MUSCLES OF THE SUPERIOR EXTREMITIES.

Name.	*Arises from*
Supra-spinatus.	The basis, spine, and upper end of the scapula.
Infra spinatus.	The cavity below the spine of the scapula.

Fig. 39.



Explanation of Fig. 39.

a, The supra-spinatus.
b, The infra spinatus.
c, The teres minor.
d, The teres major.
e, The latissimus dorsi.
f, The deltoid.
g, The triceps extensor cubiti.

Teres minor.	The inferior edge of the scapula.
Teres major.	The inferior angle and edge of the scapula.
Deltoides.	The clavicle, and the acromion and spine of the scapula.
Coraco brachialis.	The coracoid process of the scapula.

MUSCLES OF THE SUPERIOR EXTREMITIES.

Inserted into	*Use.*
A large tuberosity at the head of the os humeri.	To raise the arm.
The upper part of the same tuberosity.	To roll the os humeri outward.

Anatomists have sought for an explanation of the superiority of the right hand over the left, in the muscles, arteries and nerves of the arm; but no very satisfactory light has been thrown upon the subject. At one time, it was a common mode of getting over the difficulty, to say that the preference we give to the right hand arises from its superior strength; and that quality is owing to the manner in which the artery arises from the arch of the aorta, just above the heart. There is certainly a considerable difference in the size of the arteries in the two arms. The right, in this respect being the largest, derives its blood more directly from the fountain-head. As the power of the muscle actually depends on the blood circulated in its substance, it was very natural to refer the origin of its superior force to this cause. Here the inquiry has rested, so far as anatomical demonstration is concerned. But a formidable objection to that old-fashioned theory arises, when we find a left-handed man, whose arm does not differ essentially from any other person's left arm; and ambidexters, men using one hand just as well as the other, for example, in writing, throwing balls, turning a gimblet, using a cabinet-maker's plane, &c., seem to be entirely out of the reach of the old stereotyped theory about the artery. The preference given to the right hand conduces to its muscular development; it is both larger and stronger by use. So it is with the right foot; and hence the extreme difficulty with some of wearing a pair of shoes made on one last.

The evidence is pretty conclusive, from the universality of the law, which embraces all the inferior animals, as well as man, that the limbs on one side of the body possess certain physical advantages over the other. Both rapidity of motion and strength are thus combined, constantly improved upon by practice, and a certain mechanical excellence is thus bestowed, without which we should be incompetent to the discharge of those duties which devolve upon us.

The greater tuberosity of the humerus.	To assist the former.
The side of the groove for the long tendon of the biceps.	To assist in rotating the arm.
The anterior and middle part of the os humeri.	To raise the arm.
The middle and inner side of the os humeri.	To roll the arm forward and upward.

MUSCLES SITUATED ON THE OS HUMERI.

Name.	*Arises from*
Subscapularis.	The basis, superior and inferior edge of the scapula.
Biceps flexor cubiti.	Two heads, one from the coracoid process, the other, called the long head, from the edge of the glenoid cavity of the scapula.
Brachialis internus.	The os humeri at each side of the tendon of the deltoides.
Triceps extensor cubiti.	The neck of the scapula, and the neck and middle of the humerus.
Anconeus.	The external condyle of the humerus.

MUSCLES SITUATED ON THE FORE-ARM.

Supinator radii longus.	The external condyle of the humerus.
Extensor carpi radialis longior.	The external condyle of the humerus.
Extensor carpi radialis brevior.	The external condyle of the humerus.
Extensor digitorum communis.	The external condyle of the os humeri.
Extensor minimi digiti.	The outer condyle of the humerus.
Extensor carpi ulnaris.	The outer condyle of the os humeri.
Flexor carpi ulnaris.	The inner condyle of the humerus and olecranon.
Palmaris longus.	The internal condyle of the os humeri.
Flexor carpi radialis.	The internal condyle of the os humeri.
Pronator radii teres.	The internal condyle of the humerus and coroniod process of the ulna.
Supinator radii brevis.	The outer condyle of the humerus and edge of the ulna.

MUSCLES SITUATED ON THE OS HUMERI.

Inserted into	*Use.*
The protuberance at the head of the os humeri.	To roll the arm inward.
The tuberosity at the upper end of the radius, at its fore part, and a little below its neck.	To bend the fore-arm, which it does with great strength, and to assist the supinators.
The coronoid process of the ulna.	To assist in bending the fore-arm.
The upper and outer part of the olecranon.	To extend the fore-arm.
The back part or ridge of the ulna.	To assist in extending the fore-arm.

MUSCLES SITUATED ON THE FORE-ARM.

The radius near the styloid process.	To assist in turning up the palm of the hand.
The metacarpal bone of the fore finger.	To extend the wrist.
The metacarpal bone of the middle finger.	To assist the former.
The back of all the bones of the fingers.	To extend the fingers.
The second joint of the little finger.	To assist in extending the fingers.
The metacarpal bone of the little finger.	To assist in extending the wrist.
The os pisiforme, at its fore part.	To assist in bending the hand.
The annular ligament of the wrist, and there forms the aponeurosis of the hand.	To bend the hand.
The metacarpal bone of the fore finger.	To bend the hand.
The outer ridge of the radius, about the middle of its length.	To roll the hand inward.
The anterior, inner, and upper part of the radius.	To roll the radius outward, and assist the anconeus.

Name.	*Arises from*
Extensor ossis metacarpi pollicis manus.	The middle of the ulna, interosseous ligament and radius.

Fig. 40.

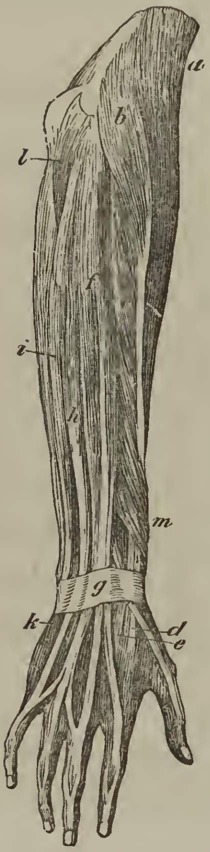


Fig. 41.

Inserted into	*Use.*
The os trapezium, and first bone of the thumb.	To stretch the first bone of the thumb outward.

Explanation of Fig. 40.

f, extensor digitorum communis, for extending the fingers; *h, extensor proprius minimi digiti*, to extend the little finger; *f*, where it unites with others; *i, extensor carpi ulnaris; l, anconeus, extensor ossis metecarpi pollicis; e, extensor primi internodii pollicis; e, extensor secundi internodii pollicis; d, indicator; g, annular ligament of the wrist; m, will be recognised; k*, an abductor of the little finger; *e, supinator radii longus.*

Explanation of Fig. 41.

a, pronator teres; b, flexor carpi radialis; c, d, palmaris longus; e, flexor carpi ulnaris; g, flexor carpi radialis longoir.

Between the elbow and ends of the fingers there are about fifty muscles. Some of them, particularly those by the sides of the fingers, are quite short and delicate. All the quick, short motions of the fingers are made by them. Their name, *musculi fidicinales*, fiddling muscles, in old books, is quite appropriately given, because the strings of the instrument are operated upon almost entirely by them. A back and front view of the fore-arm is presented in the opposite page, Fig's 40 and 41, in which all the long muscles, on the inside flexors, and on the back of the arm extensors, may be very accurately observed. Just under the skin, a silvery, tough membrane, like a silk case, is drawn closely over the muscles, to keep them from swelling too much in their contractions. As before remarked, the strength which a muscle exerts, by being pressed down to the bone, when in action, is increased a hundred fold. The beauty and proportion of the limb is wholly preserved by the case, which is called *fascia*. It is taken away, in these plans, in order to show more distinctly the parts below.

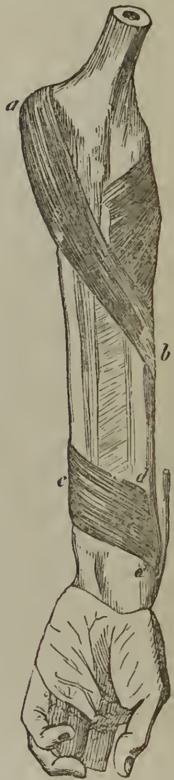
Individuals having five fingers, not an uncommon circumstance in the New England States, in the families bearing the name of Kendall, or those intimately related to them,—the extra finger has rarely had a flexor or extensor muscle. In one instance I have seen a young gentleman having five fingers; the last and smallest of the series being as liberally supplied with muscular apparatus as any of them: he also had six toes on each foot, equally well supplied with muscles.

Persons have recently been exhibited, born without arms, who were very expert with their toes, in holding scissors, whittling, mending pens, shooting with bows and arrows, opening watches, painting landscapes, with nearly as much adroitness as others could perform the same processes by their hands, &c., which merely shows that muscles can be *taught.*

Name.	*Arises from*
Extensor primi internodii.	Near the middle of the ulna, interosseous ligament, and radius.
Extensor secundi internodii.	The back of the ulna and interosseous ligament.
Indicator.	The middle of the ulna.

Fig. 42.

Fig. 43.



Inserted into	*Use.*
The convex part of the second bone of the thumb.	To extend the second bone of the thumb outward.
The third and last bone of the thumb.	To stretch the thumb obliquely backward.
The metacarpal bone of the fore finger.	To extend the fore finger.

Explanation of Fig. 42.

d, *e*, *flexor digitorum sublimis*, attached to the second bone of each finger, by four tendons, to bend the second joint; *f*, *h*, *flexor longus pollicis manus*, to bend the thumb; *a*, *b*, *c*, *pronator teres*, to pronate the hand; *g*, a slit in the tendons of the flexor digitorum, for the passage of four other tendons of another muscle which go to the points of the fingers, for bending the last joint.

Explanation of Fig. 43.

c, *d*, *d*, the *pronator quadratus*, is one of two small muscles for pronating the hand; *a*, *b*, the other, *pronator teres*.

In Fig's 42 and 43, the muscles are distinctly engraven which roll the fore-arm in *supination* and *pronation*. By turning a key in a door-lock, both sets are called into action, and it is recommended to the reader to do it, and at the same time to feel the contractions of the muscles with the other hand. Fig. 43, the bones are made so plain as to show the exact relation which the pronators have to them. On the other Fig. *e*, points to the four tendons of the muscle that bends the last bone of the fingers. Looking back to Fig. 41, page 88, it is there concealed by the flexor of the second bone of the fingers. This, in order to reach its place of destination, pierces, as it were, the tendons of the upper muscle, and thus sends its own tendons onward, through the slit.

There may be many readers who will find it difficult to understand, from an examination of the plates, the machinery of the hand, to produce such a multitude of distinct, rapid motions. As it is not always possible to see anatomical preparations, a little care in the examination of a cat's paw, for example, or the legs of a chicken, will make the subject perfectly plain. In either case, one set of tendons are perforated, for the purpose of allowing others to go farther. Nothing could have been more admirably contrived. An approximation towards the principle of the mechanism of these and various tribes of carnivorous animals, invariably having claws, may be examined in the termination of the muscles towards the hoof, in all the domesticated or social animals.

Name.	*Arises from*
Flexor digitorum sublimis.	The inner condyle of the os humeri, coronoid process of the ulna, and upper part of the radius.
Flexor digitorum profundus vel perforans.	The upper part of the ulna, and interosseous ligament.
Flexor longus pollicis.	The upper and fore part of the radius.
Pronator radii quadratus.	The inner and lower part of the ulna.

MUSCLES SITUATED CHIEFLY ON THE HAND.

Lumbricales.	The tendons of the flexor profundus.
Flexor brevis pollicis manus.	The os trapezoides, ligament of the wrist, and the os magnum.
Opponens pollicis.	The os scaphoides and ligament of the wrist.
Abductor pollicis manus.	The annular ligament, and os trapezium.
Abductor pollicis manus.	The metacarpal bone of the middle finger.
Adductor indicis manus.	The first bone of the thumb, and os trapezium.
Palmaris brevis.	The annular ligament, and palmar aponeurosis.
Abductor minimi digiti manus.	The annular ligament and os pisiforme.
Abductor minimi digiti.	The os cuneiform and carpal ligament.
Flexor parvus minimi digiti.	The annular ligament and os cuneiform.
Interossei interni, and	The metacarpal bones.
Interossei externi.	

MUSCLES OF THE INFERIOR EXTREMITIES.

Pectinalis.	The anterior edge of the os pubis.

Inserted into	*Use.*
The second bone of each finger, after being perforated by the tendons of the profundus.	To bend the second joint of the fingers upon the first, and the first upon the metacarpal bones.
The fore part of the last bone of each of the fingers.	To bend the last joint of the fingers.
The last joint of the thumb.	To bend the last joint of the thumb.
The radius opposite to its origin.	To roll the radius inward.

MUSCLES SITUATED CHIEFLY ON THE HAND.

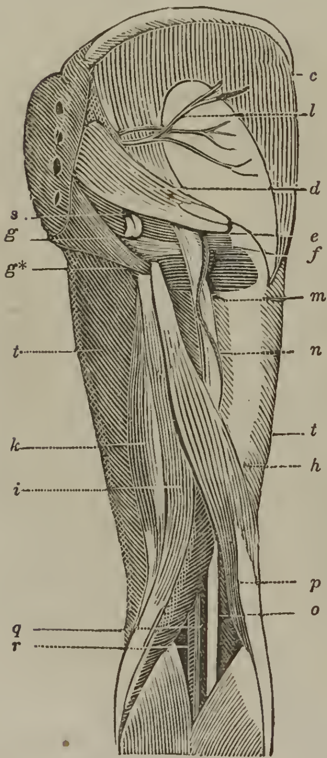
The tendons of the extensor digitorum communis.	To bend the first and extend the second phalanx.
The ossa sesamoidea and second bone of the thumb.	To bend the second joint of the thumb.
The first bone of the thumb.	To bend the thumb.
The root of the first bone of the thumb.	To draw the thumb from the fingers.
The root of the first bone of the thumb.	To pull the thumb toward the fingers.
The first bone of the fore finger posteriorly.	To move the fore finger towards the thumb.
The metacarpal bone and skin of the little finger.	To contract the palm of the hand.
The first bone of the little finger.	To draw the little finger from the rest.
The metacarpal bone of the little finger.	To move that bone toward the rest.
The first bone of the little finger.	To draw the little finger from the rest.
The sides of the metacarpal bones.	To extend the fingers, and move them toward the thumb.

MUSCLES OF THE INFERIOR EXTREMITIES.

The upper part of the linea aspera of the femur.	To bend the thigh.

	Name.	*Arises from*
Triceps adductor femoris.	Adductor longus femoris.	The upper and fore part of the pubis.
	Adductor brevis femoris.	The fore part and ramus of the os pubis.
	Adductor magnus femoris.	The lower and fore part of the ramus of the pubis.

Fig. 44.



Explanation of Fig. 44.

c, The gluteus medius.
d, The pyriformis.
e, The geminus superior.
f, The geminus inferior.
g, The obturator internus.
g,* The quadrator femoris.
h, The biceps flexor cruris.
i, The semitendinosus.
k, The semimembranosus.
l, The superficial gluteal artery and nerve.
m, The great ischiatic nerve.
n, The ischiatic artery.
o, The popliteal nerve.
p, The fibular or peroneal nerve.
q, The popliteal vein.
r, The popliteal artery.
s, The internal pudic artery, vein, and nerve.
t, *t*, The muscles on the anterior part of the thigh.

Inserted into	*Use.*
The middle and back part of the linea aspera.	To bend the thigh.
The inner and upper part of the linea aspera.	To bend the thigh, and move it inward.
The whole length of the linea aspera.	To move the thigh inward, and assist in bending it.

Besides the muscles, nerves, veins, tendons, bands, and ligaments, there are *absorbents*, an exceedingly minute class of tubes, of the utmost importance in the animal economy. From the inner edge of the great toe to the groin, there is a chain of absorbents, resembling, when magnified by a lens, a multitude of threaded eggs. It is the office of the absorbents to pick up whatever might otherwise have been wasted, and return it to the heart, that it may be appropriated to the wants of the body. These egg-shaped particles are receiving organs, immensely larger than the tubes which bring into them the fluids they suck up about the muscles. By the agency of these small bodies, which are greedy to seize whatever is presented to them, the physician is able to convey medicines into the circulation, when they could not be taken into the stomach. It may be desirable to *salivate*, or, in other words, to increase the quantity of fluid in the mouth, in order to overcome some local disease, but as mercury, in the form best adapted to produce that effect, would be injurious to swallow, it is rubbed on the skin, over these *lymphatics* or *absorbents*, being called by either name, which at once convey it into the blood; but being offensive and injurious to the body, another set of vessels discover the presence of the unwelcome visiter, and speedily go to work to throw it out of the system. In the case of mercury, it is conveyed out at the mouth, and the great flow of saliva, which keeps up a constant spitting, is nothing more than nature's scheme to wash away the noxious matter.

These absorbents sometimes suck in a poisonous matter: here an action at once takes place, of an extraordinary character. It seems as though the lymphatic, thus loaded, was conscious of its destructive burden, and instead of allowing it to flow to the next one, towards the heart, it inflames, bursts open, and discharges its contents in the form of a sore. Sometimes this ulceration may extend to the neighboring lymphatic, and so the disease be propagated even into the cavities of the body. If a serpent's fang wound the skin, the absorbents convey the venom onward, like couriers, to head-quarters, the heart, whence it is distributed at once through the system. If a bee stings, the poison is ushered along by the same organs.

The absorbents are exceedingly active agents, but so small that their existence was unknown a long time after the discovery of the circulation.

Name.	*Arises from*
Obturator externus.	The obturator ligament, and half of the thyroid hole.
Gluteus maximus.	The spine of the ilium, posterior sacro ischiatic ligaments, and os sacrum.
Gluteus medius.	The spine and superior surface of the ilium.
Gluteus minimus.	The outer surface of the ilium and border of its great notch.
Pyriformis.	The anterior part of the os sacrum.
Gemini.	The spine and tuberosity of the ischium.
Quadratus femoris.	The tuberosity of the ischium.

MUSCLES SITUATED ON THE THIGH.

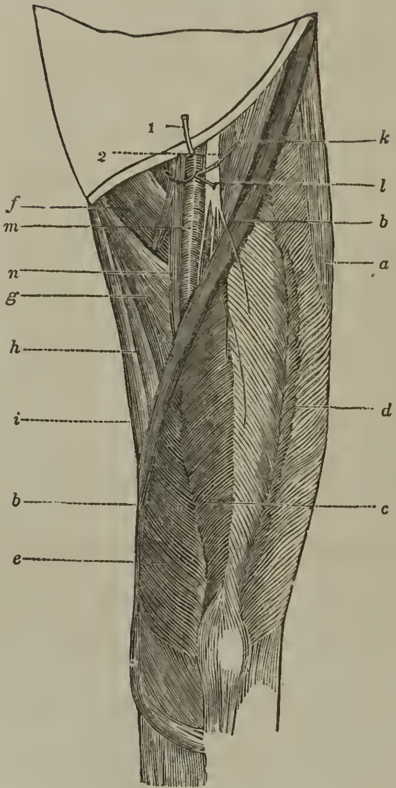
Facialis, or Tensor vaginæ femoris.	The upper spinous process of the ilium.
Sartorius.	The upper spinous process of the ilium.
Gracilis.	The fore part of the ischium and pubis.
Rectus femoris, or Rectus cruris.	The lower spinous process of the ilium, and edge of the acetabulum.
Vastus externus.	The root of the great trochanter, and linea aspera.
Vastus internus.	The trochanter minor, and the linea aspera.
Cruralis, or Cruræus.	The anterior part of the lesser trochanter.
Semi-tendinosus.	The tuberosity of the ischium.
Semi-membranosus.	The tuberosity of the ischium.

Inserted into	*Use.*
The femur near the root of the great trochanter.	To pull forward and rotate the thigh.
The upper part of the linea aspera of the femur.	To extend the thigh, and assist in its rotatory motion.
The great trochanter of the os femoris.	To assist the gluteus maximus.
The root of the great trochanter.	To assist the two former.
A cavity at the root of the great trochanter.	To roll the thigh outward.
The same cavity as the pyriformis.	To roll the thigh outward.
A ridge between the two trochanters.	To move the thigh outward.

MUSCLES SITUATED ON THE THIGH.

The inner side of the membranous fascia which covers the thigh.	To stretch the fascia.
The upper and inner part of the tibia.	To bend the leg inward.
The upper and inner part of the tibia.	To bend the leg.
The upper and fore part of the patella.	To extend the leg.
The upper and lateral part of the patella.	To extend the leg.
The upper and inner part of the patella.	To extend the leg.
The upper part of the patella.	To extend the leg.
The upper and inner part of the tibia.	To bend and draw the leg inward.
The back part of the head of the tibia.	To bend the leg.

Fig. 45.



Explanation of Fig. 45.

a, The tensor vaginæ femoris.
b, The sartorius.
c, The rectus femoris.
d, The vastus externus.
e, The vastus internus.
f, The pectinalis.
g, The adductor longus.
h, The adductor magnus.
i, The gracilis.
l, Iliacus internus.
k, The anterior crural nerve.
m, The femoral artery.
n, The femoral vein.
1, The external epigastric artery.
2, The external circumflexa ilii.

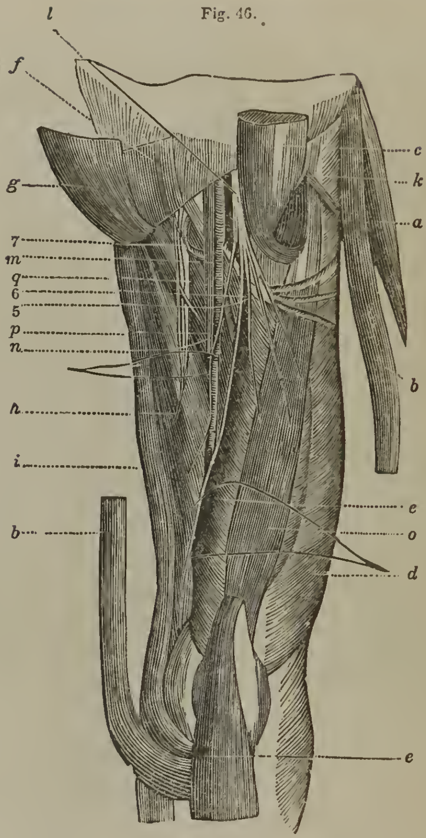
Name.	*Arises from*
Biceps fluxor cruris.	The tuberosity of the ischium.
Popliteus.	The external condyle of the thigh bone.

To a person unaccustomed to anatomical language, the names of the muscles will undoubtedly appear exceedingly unmeaning, and difficult to pronounce. This is true as respects the pronunciation; but the name, in a majority of cases, is really expressive, giving both *origin* and *insertion.* An example of this double office of the name may be noticed in *stylo-glossus*, meaning that it arises from the *styloid process*, and is inserted into the *tongue*. In hyo-glossus, the same advantage occurs: it simply informs us that it arises from the *hyoideus*, the bone of the tongue, and is inserted into the tongue. The muscles of the thigh and leg are particularly vexatious, in this respect, to a young beginner. However, by patiently exercising the mind, in a little time the system becomes familiar.

Though one bone only is embraced by the muscles of the thigh, the circumference is vastly greater of this part of the limb than the leg. This depends on the number and magnitude of the muscles, which pass over the femoris, from the pelvis, to reach the bones of the leg below the knee joint. All the muscles on the fore part of the thigh come from the upper end of the bone, and the hip, or ilium, and instead of being at all devoted to the service of the bone over whose surface they run, they are all concentrated in the kneepan, and therefore belong to the leg, as its extensors or *straighteners*. So violently have they been known to contract, that they have actually broken the kneepan into two pieces, one half held by its ligament down to its place, but the other drawn by the uncontrolled energy of the muscles several inches up the thigh. When rising from a sitting posture, the entire weight of the body is raised by these same muscles; but they would be inadequate to the task, were it not for the sliding of the kneepan up the thigh, thereby increasing the power, by removing the fulcrum from the centre of motion, till the body is erect, when it slips into a pit, made by the meeting of the ends of the thigh and leg bones. While sitting, the muscles being at rest, the kneepan falls into the space between the ends of the bones, made by bending the limb. It is on this principle that the sesamoid bones are thrown in under the tendons of the toes, to increase the power of the flexor, by removing the centre of motion further from the joint. This is a plan of nature's to protect the toe, which, being over worked, would be ruined, were not an immediate provision made for increasing its power to meet the exigency of the case.

Inserted into	*Use.*
The upper and back part of the tibia, forming the *outer hamstring*.	To bend the leg.
The upper and inner part of the tibia.	To assist in bending the leg.

Fig. 46.



MUSCLES SITUATED ON THE LEG.

Name.	*Arises from*
Gastrocnemius externus, or Gemellus.	The internal and external condyle of the femur.

Explanations of Fig. 46.

a, Tensor vagina femoris.
b, Sartorius reflected.
c, Rectus reflected.
d, Vastus externus.
e, Vastus internus, pulled outward.
f, Pectinalis reflected.
g, Adductor longus reflected.
h, Adductor magnus.
i, Gracilis.
k, Iliacus internus.
l, The anterior crural nerve.
m, The femoral artery.
5, The arteria profunda.
6, The external circumflex artery.
7, The internal circumflex artery.
n, The femoral vein.
o, The cruralis.
p, The adductor brevis.
q, The obdurator artery and nerve.
o, The cruralis, vel *crureus*.
p, The adductor brevis.

Were it not for the tendons of the vast number of muscles which slide by the knee joint, as remarked in speaking of the anatomy of the bones, this would have been an imperfect articulation. Behind, the hamstrings contribute, on either side, to the formation of a canal, in which the artery, vein and great nerve of the leg, carefully cushioned in a quantity of fat, lie so securely, that they very rarely come to any injury. One object of introducing Fig. 46, opposite, was to show the general relation of some of the blood-vessels, the nerve that supplies the fore part of the thigh, and to exhibit the muscles already shown in a preceding figure, differently displayed, which have such a bearing on the anatomy of the joint. Several of the long ones are divided, in order to give a clearer view of those which would otherwise be too much hidden to be understood. The sartorius or tailor's muscle, so called because it crosses the legs, is marked *c*, the upper portion being taken away to show *i*, the *gracilis*. In nearly all operations on the artery of the thigh, the surgeon is guided by the edge of the sartorius, a sure index. It also contributes to the lateral security of the knee.

MUSCLES SITUATED ON THE LEG.

Inserted into	*Use.*
The os calcis, with the tendon of the soleus.	To extend the foot.

Name.	*Arises from*
Gastrocnemius internus, or Soleus.	The head of the fibula, and back part of the head of the tibia.
Plantaris.	The outer condyle of the os femoris and capsular ligament.

Fig. 47.

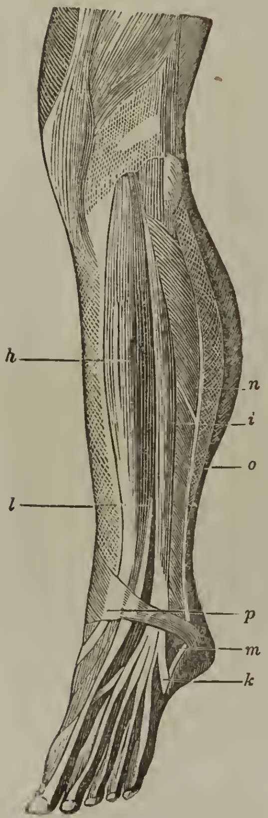
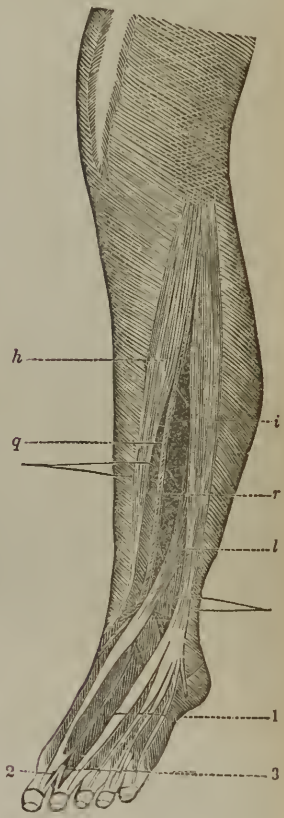


Fig. 48.



Inserted into	*Use.*
The os calcis, by a common tendon, which is called *tendo Achilis.*	To extend the foot.
The os calcis, near the tendo Achilis.	To assist in extending the foot.

Explanations of Fig. 47.

h, The tibialis anticus.
i, The extensor longus digitorum.
k, The peroneus tertius.
l, The extensor longus, or proprius pollicis.
m, The extensor digitorum brevis.
n, The peroneus longus.
o, The peroneus brevis.
p, The annular ligament.

Explanations of Fig. 48.

h, The tibialis anticus.
i, The extensor longus digitorum.
l, The extensor longus pollicis.
q, The anterior tibial artery.
r, The anterior tibial nerve.

A similar provision is made in the leg for keeping the muscles down to their proper places, that has been noticed in the fore-arm. Those bands, called annular ligaments, which encircle the ankle, to prevent the tendons, as they run upon the top of the instep, from flying out from the bones, in a high state of contraction, must excite admiration. This they have a constant tendency to do. If a person is walking up a flight of stairs on his toes, he will then perceive the strong action of the tendons, and the reaction of the ligaments upon them. All those animals which climb, as squirrels, monkeys, bears, and some others, have the fascia or limb cases much thicker, in proportion to the size of the body, than in man. All the tendons of the toes and fingers are bound down to the bones by inelastic bands, in a similar manner. Birds, particularly those that roost, have a beautiful web of ligamentary threads wound round the leg, just above the toes, for restraining the tendons.

Fig. 46 displays an intricate mass of muscles, originating between the upper extremities of the leg bones. For nearly a foot below the knee, it is difficult to designate one from the other, on account of the intermingling of the fibres. However, the tendons of each are distinct. No important vessels or nerves are exposed on the skin: on the opposite side, however, they are to be found, safely protected by muscles, bones and fascia.

Name.	*Arises from*
Tibialis anticus.	The upper and fore part of the tibia.
Tibialis posticus.	The back part of the tibia, interosseous ligament, and adjacent part of the fibula.

Fig. 49.

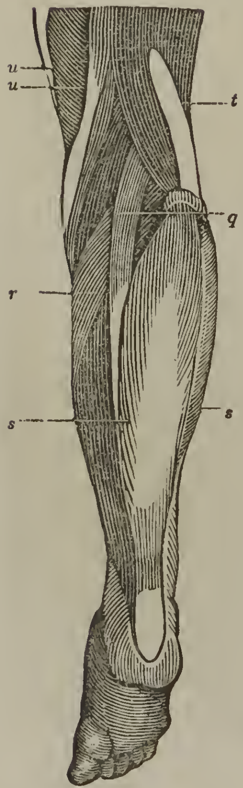


Fig. 50.

Inserted into	*Use.*
The os cuneiform internum.	To bend the foot.
The middle cuneiform bone, and upper part of the os naviculare.	To move the foot inward.

Explanations of Fig. 49.

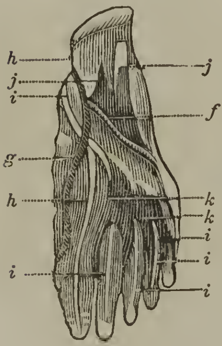
q, The plantaris.
r, The popliteus.
s, The soleus.
t, The biceps, forming the outer hamstring.
u, *u*, The semitendinosus and semimembranosus, forming the inner hamstring.

About the knee and ankle joints bone-setters have played, and are still playing, a high-handed game of quackery and imposition. On that account, therefore, it has been an important object to embody as much general information in relation to the anatomy of the lower limbs as possible, and at the same time avoid writing a professional essay on the diseases and incidents to which they are particularly predisposed. Three bones only enter into the composition of the knee joint; yet in this land of common sense individuals injure the articulation, and have it made well, by the reduction of *six* or *seven!* The ankle joint, made up entirely of three bones, is often cured by having *several little bones thrust into* place!

In the immediate neighborhood of these joints, a multitude of tendons have been seen, in the preceding diagrams, on which their perfection depends. By a thousand accidents to which they are exposed, the tendon of a particular muscle may be so prodigiously strained as finally to become inflamed. No pain is more severe nor more tedious in point of duration than sprains, or over stretching of the tendons and ligaments. Though slow to feel, when once roused they are as difficult to manage as the bones, because they possess a vitality so low and so far removed from the sensibility of the soft parts, that remedies are a long time in effecting a restoration. To an inflammation therefore, and not to the out-of-joint condition of the little bones, is to be imputed the cause of protracted lameness in a majority of cases. The metatarsal bones of the instep are not thrown out of place once in a hundred instances where it is supposed they are.

Name.	*Arises from*
Peroneus longus.	The head of the tibia, and upper and outer part of the fibula.
Peroneus brevis.	The outer and fore part of the fibula.
Extensor longus digitorum pedis.	The upper part of the tibia, interosseous ligament, and inner edge of the fibula.
Extensor proprius pollicis pedis.	The upper and fore part of the tibia.
Flexor longus digitorum pedis, profundus, perforans.	The upper and inner part of the tibia.
Flexor longus pollicis pedis.	A little below the head of the fibula.

Fig. 51.



Explanations of Fig. 51.

f, The external plantar artery.
g, The internal plantar.
h, The tendon of the flexor longus pollicis.
i, The tendons of the flexor longus digitorum.
j, *j*, The massa carnea Jacobi Sylvii.
k, *k*, *k*, The lumbricales.

MUSCLES CHIEFLY SITUATED ON THE FOOT.

Extensor brevis digitorum pedis.	The upper and anterior part of the os calcis.
Flexor brevis digitorum pedis, perforatus sublimis.	The lower part of the os calcis.

Inserted into	*Use.*
The metatarsal bone of the great toe.	To move the foot outward.
The metatarsal bone of the little toe.	To assist the peroneus longus.
The first joint of the small toes by the four tendons.	To extend the toes, and separate them from one another.
The convex surface of the bones of the great toe.	To extend the great toe.
The last bones of all the toes, except the great toe, by four tendons.	To bend the last joint of the toes.
The last bone of the great toe.	To bend the great toe.

Notwithstanding the multitude of bands, muscles, cords and vessels, were it not for the broad sheet in the sole of the foot, reaching from the heel to the roots of the toes, like the sole of a shoe, all the parts we have been considering would have been inadequate to its security. The *plantaris*, the name of this ligament, binds the arch of the foot, and effectually prevents the bones from being spread apart, and at the same time constitutes a firm external defence for the muscles, nerves and vessels. A similar broad ligament exists in the palm of the hand, for the same purpose.

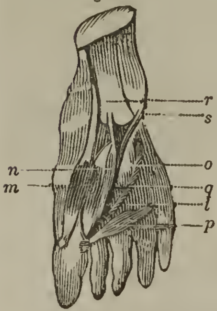
One reason why wounds in the sole of the foot are so painful and dangerous, when made, for example, by treading on a nail, arises from the injury the muscles suffer behind this *aponeurosis* or insensible membrane. A great number of tendons, arteries, and nerves are compressed into small channels; and hence incisions from the bottom are always attended with hazard.

MUSCLES CHIEFLY SITUATED ON THE FOOT.

The first bone of the great and other toes, except the little.	To extend the toes.
The second phalanx of each of the small toes, by four tendons, which are perforated by those of the flex. long. dig. ped.	To bend the second joint of the toes.

Name.	*Arises from*
Lumbricales pedis.	The tendons of the flexor longus digitorum pedis.
Flexor brevis pollicis pedis.	The fore part of the os calcis, and external cuneiform bone.
Abductor pollicis pedis.	The inner and lower part of the os calcis.
Adductor pollicis pedis.	The ligament extended from the os calcis to the os cuboides.
Abductor minimi digiti pedis.	The tuber of the os calcis, and metatarsal bone of the little toe.
Flexor brevis minimi digiti pedis.	The root of the metatarsal bone of the little toe.
Transversales pedis.	The ligament connecting the bones of the tarsus.
Interossei pedis interni. Interossei pedis externi.	The metatarsal bones.

Fig. 52.



Explanations of Fig. 52.

l, The plantar arch.
m, The flexor brevis pollicis.
n, The adductor pollicis.
o, The flexor brevis minimi digiti.
p, The transversalis pedis.
q, The interossei.
r, The long ligament of the calcis.
s, The tendon of the peroneus longus.

Inserted into	*Use.*
The tendinous expansion at the upper part of the toes.	To draw the toes inward.
The first joint of the great toe, by two tendons.	To bend the first joint of the great toe.
The first joint of the great toe.	To move the great toe from the rest.
The outer sesamoid bone, or first joint of the great toe.	To draw the great toe nearer to the rest, and to bend it.
The first joint of the little toe externally.	To draw the little toe outward.
The root of the first bone of the little toe.	To bend the little toe.
The tendon of the adductor pollicis.	To contract the foot.
The metatarsal bones.	To draw the smaller toes towards the great toe, and assist in extending the toes.

APPARATUS OF JOINTS,

OR BURSOLOGY.

Within the joints, or in their immediate vicinity, there are small sacs, containing a glairy, oily fluid, which is poured out between the articulating surfaces, to prevent friction; the name of this substance is *synovia. Upon the same principle that any machinery is kept oiled, the joints are lubricated.* When the secretion of the *synovia* is imperfect, or scantily effused into the joint, the highly polished surfaces of the cartilages become rough, dry, and subsequently inflamed.

Even in the sheaths of the tendons, these oil bags are considerably numerous. About the wrist, elbow, shoulder, hip, knees, and ankle, they are large, but of various shapes, according to the space afforded them. Where the most motion is required, there are the largest sacs, secreting and throwing into the place a copious quantity of the oil. A disease of the *bursæ mucosæ*, which is the scientific name of the sacs, is familiarly known as the *white swelling*, particularly of the hip and knee.

FLUIDS, OR ANGIOLOGY.

THE HEART AND CIRCULATION OF THE BLOOD.

The ancients were totally ignorant of the circulation of the blood.

By a long course of observations, it was commonly admitted that there were in man, for example, two sets of

---

Of what does bursology treat?
Describe the object of the synovial fluid with the joints?
Where are the largest of these sacs placed?
Are they ever diseased?
What is angiology?

tubes, which extend through the body, and they assigned to each many absurd and ridiculous functions.

As one set of vessels were superficial, directly under the skin, filled with the *venous blood*, which quietly moved along the smooth duct, from some unknown point to another equally obscure, they were fully satisfied that it belonged, in some way, to the body. On the other hand, by various accidents, they had frequent opportunities of viewing the deeper seated vessels, throbbing and jetting blood in recent wounds; but as the color of their contents was different from that in the veins, and the activity that was manifested by these tubes, when exposed to their astonished vision, altogether different from the motionless veins, the idea was at once admitted that these, which were denominated *arteries*, constituted the laboratory of the animal spirits, or in the arteries that the powers of the soul were generated, in combination with atmospheric air, which found its way into the reservoirs of life, through the puffing and blowing exercises of the lungs. When the artery was cut, and the warm blood was forced out by strong pulsations, then the spirit within was angry, and so vented its displeasure and spite, like a snarling child, by spurting out its own precious self through the incidental aperture.

Upon notions as rational as these, learned men constructed some of the strangest theories that ever beset the imagination. When the whole subject of the use of the arteries and veins was supposed to be clearly understood, those sage investigators of the sublime and beautiful rested from the weight of their labors, and subsequently established certain doctrines, which held a despotic sway for centuries; yet they were as far from truth as possible, and, worse than all, no person of common sense dared to call them in question.

Who but a blockhead would ever have entertained a notion like this, viz. that the blood ran out from the heart through the day, or while one was awake, and returned again at night, when the individual retired to his slumbers! Who but a profound dunce would have suggested the novel theory that *weariness*, the sensation of *being tired*, was in consequence of being so long awake, that the blood had all run out from the fountain-head: and

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Where did the ancients suppose the animal spirits elaborated?

when one could not move any longer, from complete exhaustion, why nature indicated at once what was to be done: only lay the poor sufferer on a bed, the recumbent posture being highly favorable, the blood immediately took a downhill direction, and when it had all reached home, and was snugly settled down in one of the chambers of the heart, the tendency to death was suspended, the man recovered his accustomed strength, and bright and early the next morning the same truant blood was ready to travel over the old ground again!

Thus it will be plainly understood, that the arteries were expressly set apart as a habitation for the *spirit* or vital principle: the veins, because they were less noble, were on the outside, while the others within were exclusively appropriated to the to and fro, night and morning circulation of the blood.

Another discovery, equally surprising, and in exact keeping with the foregoing arrangement, related to the heart. They saw a little thing carefully boxed up in the chest, between the right and left lung, which to all intents and purposes satisfied the student of nature that it was *very hot*, or it would not have been confined and surrounded by two great bags of wind: it was kept tolerably cool by constant respiration.

The heart being decidedly a hot affair, there was a grand field for exclaiming and proclaiming the wisdom of nature, in providing such a delicate, and at the same time simple, but perfect contrivance for keeping down its temperature below the boiling point. It was laced up in a straight jacket, the *pericardium*, vulgarly called heart-case, of a texture so firm, that it was as self-evident as that the earth was the centre of the solar system, that this organ was liable to prodigious paroxysms of rage, and would burst from its prison, were it not thus secured. Two points were thus satisfactorily settled; viz. that it was very hot, and very unruly.

Again,—within, there were certain apartments, which took the sensible and significant names of *auricles* and *ventricles*, because the walls of the one bore some fanciful resemblance to the ears of a dog, but which, by the way, bear just as much resemblance to the horns of the new moon; and in these cavities certain curious operations were going on, which none but very wise philosophers understood. These consisted in the mixing of air

and blood, the instantaneous development of certain matters and things which constituted life, and gun-powder like explosions, consequent upon the ingress of cold air in the furnace of the heart.

In reality, had those investigating geniuses of the olden time, whom it is so fashionable to admire, so classical to praise, known any thing of the modern properties of the steam-engine, it is altogether probable they would have had much to say on the heart's property of generating power by converting its liquid contents into vapor, and, in the sequel, laboriously explained the causes which occasionally oppressed, which clogged the wheels of vital action, and which, in plainer language, sometimes burst the boiler.

We have merely sketched an outline of the general views which were entertained of the physiology of the system by the ancients; views, it would seem, so absurd that the reflections of a school-boy would have overturned them: yet, strange as it now appears, they were carefully transmitted from one generation to another, for many centuries, and treasured up as the profound discoveries of antiquity.

THE HEART.

It would seem, at first view, from the high office of the heart, so constantly found in all animals with which we are familiar, that no organized being could possibly exist without it. Strange, however, as it may appear, there are various classes, in the lowest orders of animal creation, which are totally destitute of it; still, they have blood, which can under no circumstances be dispensed with; but it is not propelled by one single organ through the vessels. There is a compensation, however, in the structure of the primitive vessels, or, to be understood, a blood-vessel takes upon itself all the functions of a heart, exerting by successive pulsations a power adequate to the physical requirements of the body in which it is found.

Numerous, indeed, are the insects and vermin in which this kind of organization is discoverable. But it is not an organization favorable to longevity, for those in

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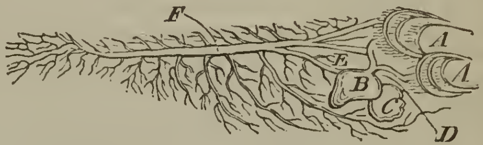
Do any exist without a heart?

which this simple apparatus exists are the beings only of a day; they flit in the sunshine a few hours; the object of their creation is attained, and they die.

A resemblance to this sort of machinery is noticed in fishes; though they have a heart, it is exceedingly imperfect, when compared to the same organ in warm-blooded animals.

Fig. 53.



Explanation of Fig. 53.

A, *A*, are the fringes of the gills, attached to half hoops of cartilage. These threads, which are of a bright red, are the extreme terminations of the branchial arteries; in an animal breathing air, the same vessels are called *bronchial arteries*.

B, the ventricle of the heart, or forcing-pump, which drives the blood with which it is distended into a single artery. Just beyond *B*, the artery *D* divides into two branches, leading to the gills on either side, in equal quantities. Precisely like this is the right heart of man. Instead of being thrown into gills, the branches direct the blood into the lungs. *C*, the auricle, or first receiving cavity of the heart. All the veins of the body in all animals, whether belonging to the land or water, ultimately unite into one tube, and that empties its blood into the auricle.

E. In this diagram, *E* is the *branchial vein* of the right gill, soon united to that from the left side. The blood has been changed in the gills, where it was sent by the heart, by being brought in contact with the air in the water, and now, being fit for the purposes of the system, is returned by these veins, to a great vessel lying under the back-bone.

F. This is the reservoir of the revitalized blood: at its commencement in the gills it is like a vein, but the main trunk now assumes the functions of an artery, or indeed a second heart. It contracts and propels its contents over the body. Here then is a tube taking upon itself the office of the left heart of land animals.

Reference might be made to very many curious modifications of this blood-propelling apparatus, positively necessary to the existence of all organized beings, in the oyster, cuttle-fish, birds, lizards, serpents, tortoises, frogs, tadpoles, and some other reptiles.

The fish has but *half a heart*. All their blood—and in some of the huge monsters of the ocean there is a prodigious quantity—is sent its rounds by an *artery*, and not by a heart, or any particular part of one. A force is

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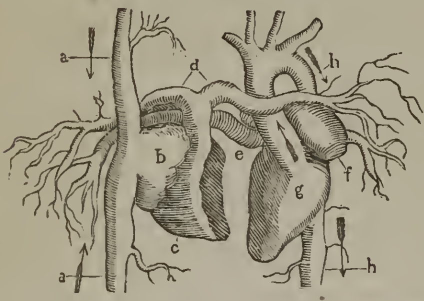
Describe the use of gills in fishes. Have aquatic animals a heart, in its organization, like that of the air-breathing animal?

exerted by the contractions of a single vessel equal (for it must be in sharks of thirty feet in length) to a moderately sized fire-engine. The blood, by each pulsation, is driven through as much space in a given time as the water is thrown by the piston of the engine.

In the mammalia, that is, animals breathing air, the heart is the centre of the circulation—the point from whence the blood starts, and the instrument of propulsion, by which it is kept going in an endless round, in the body. It is a forcing-pump, by which a column of fluid is raised, and an imitation of its mechanism may be examined in machines used for filling tanks in upper apartments. One is self-moving, having incorporated within its own substance the wonderful power of generating physical strength; while in the other an extraneous force must be applied, somewhere, to put it in motion.

In warm-blooded animals the heart is a compound engine. If we go back to the fishes it is there single; but in man, quadrupeds and birds, it is double: they have two hearts, and both of them are forcing-pumps. Man has *two hearts*. By being united, less substance is required; and the union of the two actually conduces to the greater muscular power of both.

Fig. 54.



Explanation of Fig. 54.

By this engraving, the reader will readily understand what we mean by the *two hearts* of man, and other warm-blooded animals, as they are

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Where is the double heart found? Is the heart a forcing engine, or a passive, receiving organ?

Explain the mechanism of the single heart; also, that of the double one.

here exhibited, and as they appear when dissected apart. Each one of them is a perfect organ by itself, and the one is perfectly independent of the other. That having the letter *b* upon it is the *right* heart, and that with a *g*, the left. This is a front view, or like looking into the chest of another person. The right heart is the engine of the *lungs*, for it supplies those organs exclusively. The left heart throws the blood, as already remarked in the text, round the curve above *g*, in the direction indicated by the arrows, over the entire body.

a, *a*, are the *cavas*, or great veins, returning blood from the head and arms, and lower extremities. The uppermost is the *superior vena cava*, and the one below the *inferior vena cava*. The arrows show the direction of the returning currents of venous blood, to *b*, the *auricle*, which forces it into *c*, the *ventricle*, which again forces it up into *a*, *d*, the pulmonary artery, where it divides, to go to each lung; *e*, is one of the *four pulmonary veins*, which convey the blood, just forced into the lungs, into the *auricle f*, of the left heart. When that contracts, it drives its blood into *g*, the *ventricle*, which, in its turn, forces it onward again into the arch, or the *aorta*, the main pipe, where it glides along in the direction of the arrow, dividing into smaller streams on its way, and finally goes down the *descending aorta h*, to supply the body below.

There are many animals which have only the right heart, but none that possess the *left one* alone. The fish's heart, in the plan preceding this, is the single, equivalent to the right heart of man.

That there might be no interference, no irregularity, but perfect order and harmony, only one acts at a time. The right heart rests while the left moves, and then, in perfect obedience to a law which cannot be explained, operates in its turn.

In configuration, the heart has no such vulgar shape as we are told in some of the books, like the ace of hearts on a playing card. It is a short cone, lying obliquely across the breast, the point of which beats, when in an erect posture, between the sixth and seventh ribs of the left side.

Within there are four apartments, so irregularly shaped that they cannot be likened to any thing. Each heart has its two cavities, communicating with each other by an orifice, about an inch in diameter, but a complete valve is suspended on the margin of the opening, like a gate, to close it, that all communication may be instantaneously interrupted, as we shall ascertain to be indispensably necessary, at each pulsation. Moreover, to prevent the heart from ever being over distended, from having its walls put too much upon a stretch, little cords of astonishing tenacity run from one side to the other, crossing and re-crossing each other in all directions, which also assist,

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Do both hearts act at the same moment?

How many cavities has the heart—calling the two a single organ?

by contracting, to squeeze it, as it were, together, in forcing out its contents.

To secure it still farther, guarding against all contingencies, the heart is enveloped in a tough, slightly elastic case. Having this support, were the internal straps to be rent from their attachments, the swelling heart would be met from without by its covering, and prevented from being ruptured by the accumulation of the blood within.

Lastly, that the freedom of motion might never be abridged, the heart is suspended at the top of the chest, by its own tubes, being at liberty to swing in the triangular space given it between the lobes of the lungs, according to the various attitudes the body assumes. This is not all; the heart constitutes a hollow muscle, being as completely flesh as the muscles of the arm. Besides, it possesses all the essential characteristics of every muscle, the inherent property of contractility.

Having explained the fact that there are two hearts, it is now necessary to show the necessity of this arrangement, which is no easy matter, inasmuch as we are to adapt our demonstration to the capacity of the young.

Throughout the system there are two sets of tubes for conveying blood; one conducting it through the body, and the other returning it. To be serviceable to the system, which is the final cause of the elaborate machinery under consideration, two other important organs must necessarily claim attention, viz. the stomach and the lungs.

In the former, the food is converted into a milky liquor, from whence it is actually conveyed into one of the cavities of the heart; but before it can be of any service, it must first be mixed with that already in the veins. A chemical change is effected in it by being exposed to the action of the atmospheric air, that makes it blood.

When the first process is completed, the next object nature has in view is to distribute it, and the left heart is the apparatus by which it is effected. There is no communication between the cavities of the two hearts, but we perceive that the blood, which is pouring into the right side,

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Why are not the walls oftener ruptured by the pressure of the blood within?

How is the heart connected or attached in the chest?

Is the heart a muscle?

Are there valves in the heart?

How does the heart carry on the circulation?

must be thrown somewhere, and as it cannot go into the left, where, the query will arise, does it move? directly into the lungs. From thence it is collected, and by four branching tubes carried to the left heart. Thus the left heart forces it in all directions from the centre, and the right heart forces that which has been returned into the lungs.

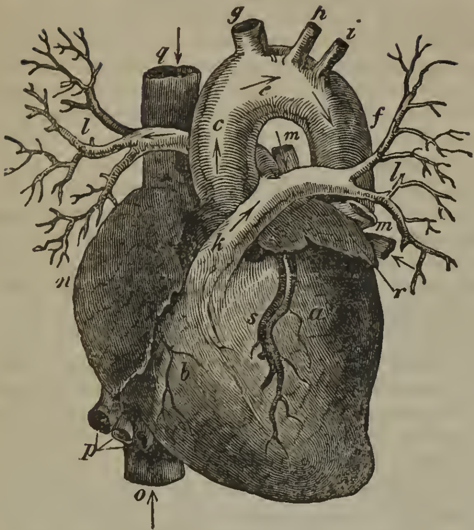
By an untiring labor of the two hearts, acting alternately, from birth till death, the blood, that important substance, on which life depends, is kept always going and coming; and whatever property or quantity is lost on the route, is supplied by the activity of the stomach, the great laboratory in which the material is manufactured of which it is originally made.

Authors detail the particulars of what they call the *two circulations*, viz. the *greater* and *lesser*, by which is to be understood, that the right heart and lungs constitute this lesser, because the force of the engine is only exerted to throw its contents into the air cells of the lungs. On the other hand, the greater circulation means the left heart and all the arteries leading from it, quite to the extremities.

As the power to be exerted by the left heart, in order to throw the blood the entire length of the body, is vastly superior to its fellow, which is only required to push its volume of blood about ten inches, so it is proportionably stronger in its substance, thicker in its walls, and more sensitive to the application of stimuli. In the act of dying, the left heart invariably clears all its cavities, and therefore is always empty on dissection, but the right heart remains full and burthened.

Which heart or half belongs to the body and which to the lungs? Explain what is commonly understood by the two circulations. Which of the two hearts possesses the greatest power?

Fig. 55.



Explanation of Fig. 55.

The double heart of man: *q*, *descending vena cava*; *o*, ascending *vena cava*; *n*, *right auricle*; *b*, right *ventricle*; *k*, *pulmonary artery*; *l*, *l*, *right* and *left* branches of this artery, going to the lungs on either side of the chest; *m*, *m*, *veins* of the *lungs*, which return what the artery sent in, to *r*, the *left auricle*; *a*, the *left ventricle*; *c*, *e*, *f*, *aorta*, or great artery of the body, rising out of the left heart; *g*, *arteria innominata*; *h*, the *subclavian artery*, going to the left arm; *i* the *carotid artery*, which goes up the side of the neck to the head. *Note*—the arrows show the course the blood moves in each of the vessels demonstrated with the heart; *n*, right auricle; *m*, *m*, veins of the lungs; *s*, left coronary artery. *P*, veins returning blood from the liver and bowels.

There is no essential difference in the external appearance or internal organization of the heart of man and breathing animals generally; hence, in a cabinet, it would be exceedingly difficult for a practical anatomist to designate the human from the heart of a brute, provided they were of equal dimensions.

Nothing is easier than to fill a heart with wax, or even plaster paris, in order to exhibit, distinctly, all its vessels and its exact shape in a state of distension. The heart of any of the domestic animals, procured at the market, may be thus filled, and kept for many years.

Ultimum moriens, the last part to die, was an accurate remark of the old anatomists. In reptiles and fishes so

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Is there any difference between the organization of the heart of man and brutes?

How would you preserve this complex engine, in order to study its mechanism?

irritable is the heart—and they possess only one half of ours, equivalent to the left one—that long after the body is dead, the heart, separated from all its connexions, will continue to pulsate upon the table for half an hour; when it has exhausted itself, if it be touched with the point of a pin, it will be roused into activity again, and beat and throb as though it were conscious of making a desperate struggle for existence.

When the frog's heart has been a whole hour under inspection, it will continue to pulsate, even by blowing it. The mangled body, all this time disembowelled, shocking as it may seem, leaps about the house, without a heart, without blood, and with lacerated nerves and muscles, apparently just as well as before those cruelties were commenced.

Each heart has two cavities, as repeatedly remarked; but for the sake of conforming to the usual method of description we will say the heart has four cavities, two of which are the *auricles*, being uppermost, and two directly beneath them, the *ventricles.*

The numerous threads, already spoken of, reaching from one side to the other, are called *cordæ tendinæ*, and those which are fleshy in the middle *columnæ* and *massæ carnæ.* Their office is merely to prevent the auricle from being overcharged, acting precisely upon the principle of a tape the manufacturer tacks in to keep the lid of a trunk from falling open so far as to wrench off the hinges.

From the lower part of the auricle the opening into the ventricle is a smooth, round hole, opened and closed by a valve that springs downward, but never, in any instance on record, has it been pushed up through. The valve is curiously supported by little tags, lines and weights to prevent its being pressed by any force that might have a tendency to press it the wrong way, and at the same time these accompaniments assist in moulding the edges precisely to the ragged surface of the border of the hole, so that it shall be completely tight. That it is impervious, may be inferred from the fact, that the heart has been repeatedly ruptured by its own exertion, on the blood filling its ventricles, or auricles, yet the strong

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What is meant by a ventricle? Auricles—where are they in relation to the auricles? Is there a communication between these two apartments?

walls, half an inch in thickness, gave way, while the tiny, transparent valve maintained its place.

The strips which enter into its composition being fancifully imagined to be three, it takes the name of *tricuspid*, because it has three points. On the top of the auricle two or three large veins present their mouths: one is the *vena cava superior*, the great trunk which brings all the blood from the head and arms into the reservoir; and another, nearly opposite, is the *vena cava inferior*, in which all the blood is brought from the feet and body. There is a third, very much smaller, however, the *coronary vein*, returning the blood which has circulated exclusively in the substance of the heart. Over this last opening is a crescent-shaped valve, highly important, for were it not there, every time the auricle contracted it would force the blood wherever there was no resistance, which, therefore, instead of allowing the venous blood to return into the common fountain, would be continually driven onward, so that the heart itself would suffer from an obstructed circulation: this half-moon shaped valve, swinging downward, entirely opposes the ingress of blood from the auricle, yet freely allows that coming from the heart to make its exit by the valve.

Can we contemplate any thing more purely mechanical than this contrivance? Can any one in his senses argue himself into the absurd belief, that this peculiar arrangement, this striking adaptation of parts, all concurring to the utmost perfectability of the machine, splendid in its structure, *happened all by chance!*

The auricle being filled, the sense of fulness—a property entirely independent of the mind, wholly beyond the control of the laws of volition—prompts it to expel it. This it does by collapsing; by simultaneously contracting all its parts upon the mass within, which is thereby driven, *per saltum*, through the great canal, down into the ventricle, the second apartment. To admit it there, a preparation is necessary on the part of the ventricle, which consists in relaxing itself to enlarge its capacity for receiving the portion that is on the way from the auricle. At the instant of being filled, the tricuspid valve, which

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What is the character of the valves?
What is the appropriate stimulus of the heart?
What is the order of action with the valves?

was before pendulous, flaps back, cuts off all further communication, and thus holds all that has been admitted, to be afterwards disposed of.

Because the auricle is obliged to make an effort only strong enough to urge its contents by the valve, it is comparatively slightly made, and weaker than the ventricle.

Having the ventricle filled, let us watch the process by which it clears itself. It has been premised, that its duty is to push the blood to the lungs, a distance of about ten inches, though if we suppose that the extreme ramifications of the bronchial arteries are gorged by each throw of the ventricle, the power is equal to projecting the stream between seventy and eighty feet. This point is rather dubious; anatomists have not satisfied themselves whether the ventricle actually presses the blood to the extreme twigs of the lungs, or only sends it beyond the valves in the mouth of the pulmonary artery, hardly a distance of seven inches. If it were not designed to exert a force more than ten times as great as the auricle, surely it would not have been made so very much stronger, and so amply provided with materials for that purpose.

If the auricle can send a column of blood ten feet, the ventricle, by its additional physical advantages, could throw the same quantity fifty feet in precisely the same time. This looks a little like being able to reach the lungs, notwithstanding the reasonings of authors to the contrary. When the stimulus of distension creates the exciting sensation, the walls contract, as in the other case, and every drop of the blood goes through a very delicately smooth, round hole, the only outlet from the ventricle, besides the place of entrance, and this is the beginning of the *pulmonary artery*, the great blood-vessel of the lungs. Here we leave the description of the right heart, for the present, lest minuter details should distract rather than enlighten those who may, perhaps, endeavor to obtain their first accurate notions of this local piece of anatomy from our dissertation.

Much as the *heart of the body*, that on the left side, resembles the one before us, there are peculiarities requiring a careful and patient investigation, if we are desirous of perfectly comprehending its structure and functions.

What vessel does the blood enter from the right heart?

Were a well prepared specimen of the heart to be lying before the reader, he would regard the general appearance of strength in the left side, as though more depended upon it in the economy of life, than on its associate. Such is truly the fact, that the power manifested by it is immensely superior.

United, as just seen, are the left auricle and ventricle, with a similar valvular communication between them. The left auricle is considerably larger than the right, but bears more resemblance to a square box, in a state of distension, than a sac. The entire office of this is to expel the blood forcibly into its neighboring ventricle. Uniting by degrees, all the veins gradually terminate in four considerable trunks, in the two sides of the auricle, nearly opposite to each other. Two of them bring the blood from the right, and the others from the left lobes of the lungs.

When the ventricle is full, let it be recollected that it must send its blood in two directions, viz., towards the head, as well as the feet; and at the same time, supply all the intermediate viscera, muscles, nerves, and even the very bones themselves, however remote from the centre of the circulation. By its contraction a valve, called the *mitral*, shuts back to prevent a regurgitation; hence the blood can only escape through the canal provided for it. This is a long, strong tube, nearly an inch in diameter, in man, known as the *aorta*. Directly in the calibre of the aorta are three valves, so adjusted to the condition and shape of the artery, that the three, in being spread horizontally, (the posture has no influence on the action,) effectually close the channel, so that nothing which may have passed the portals can possibly be returned. Thus the functions of the two hearts are analogous; the principle of propulsion is the same, and indeed, when the office and organization of one is understood, it illustrates sufficiently well the other.

The line of union between the two is termed the *septum cordis*. All the fibres of the two ventricles have a winding direction, which give the heart a twisting or vermicular kind of motion in its pulsations. The alternately swelling and collapsing, as when full, or empty,

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Why were the two hearts united—are there any advantages derived from the connexion?

are the *disastole* and *systole*, terms used to express the pulsations.

Although the heart is the fountain of life, dispensing the blood either directly or indirectly to the smallest twig, wherever located, in the body, it requires a circulation of the same vitalizing fluid to sustain its own existence.

For this purpose there are vessels creeping out at the sides of the aorta, at right angles with the trunk, just above the semi-lunar valves, which wend their way directly to the dividing horizontal line, between the auricles and ventricles, where, carefully imbedded in a triangular depression, out of the way, the *coronary arteries* are continually sending off branches that dip down into the substance of the heart, supplying it abundantly with arterial blood. When it has completed its route, and is in readiness to go on again, to get within the cavities of the heart, from the extremities of the coronary arteries *veins* commence, called *coronary*, which keep gradually uniting, and ultimately coalesce in one single tube, the *coronary vein*, of the diameter of a writing pen, whose mouth was found, on examination of the right auricle, behind a beautiful little coronary valve. In this way the substance of the heart is supplied with nutriment, to sustain it in a course of activity that never tires, and which never ceases till death.

NERVES OF THE HEART.

These are few, arising from the *sympathetic* and *eighth pair* of nerves. The *sympathetic* is a kind of line of union receiving a deputation from all the principal nerves throughout the frame, by which a connexion is maintained with all the different parts of the complicated whole. The *eighth pair* of nerves arise in the brain, but traverse down the side of the neck into the chest, following the course of the windpipe and æsophagus, quite to the stomach. From these, there being a pair, one on either side, filaments shoot off to the heart. The minutiæ of the course is not essential. In this way the heart holds a line of communication with the stomach: by the other set

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Where is the vessel called coronary vein?

Has the heart any nerves?

From what source are they derived?

of nervous cords, it possesses a general relationship to all the portions of the body.

Placing the heart entirely beyond the reach of the inconstant, unstable will, was a happy circumstance in the economy of our being. No one can put a stop to the pulsations of his heart, in a fit of despair or rage, as thousands would, were it possible. It still works on, by night as well as day, though the intellect sleeps, and thus we are safely protected. If the pulsations and the maintenance of life, through the heart's agency, depended on our vigilance, how soon we should forget the charge, and suffer the chronometer of life to run down the first time it was left in our care.

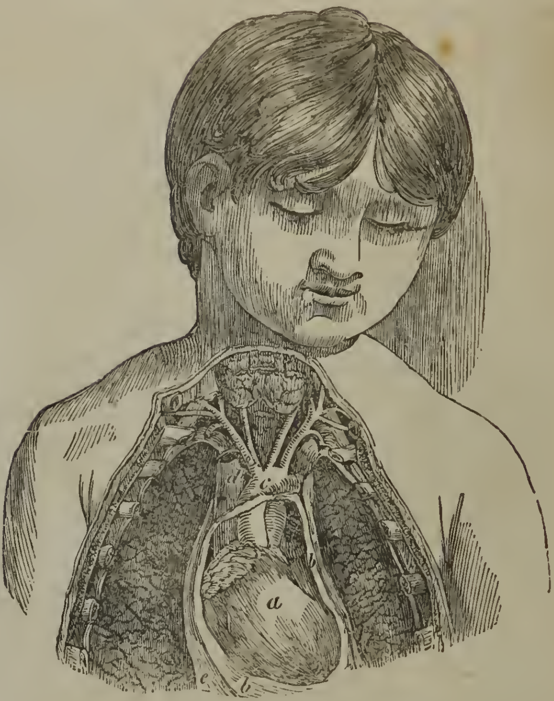
HEART-CASE, OR PERICARDIUM.

An allusion, merely, has been made, to the heart-case, or *pericardium*, the office and importance of which is very likely to be overlooked. It is the membrane which farmers sometimes make money purses of, on account of its softness, toughness and capacity. In the chest, lying between the breast bone in front and the spinal column behind, it is like a bag, kept on the stretch by a hoop: on either side are the lungs, in their own cavities. A duplication of its inner coat invests the substance of the heart, closely, and on the surface, spread over the heart, as well as from the inside of the pericardium, a halitus is exhaled, that lubricates the cavity, admitting the gentlest possible motions, as it swings in the apartment. Though the heart is moving about, its apex being sometimes at one point, and sometimes at another, according to our position, the pericardium never moves from its place, being always kept upon the stretch.

Is the heart at all influenced by the will?

Describe the use of the pericardium.

Fig. 56.



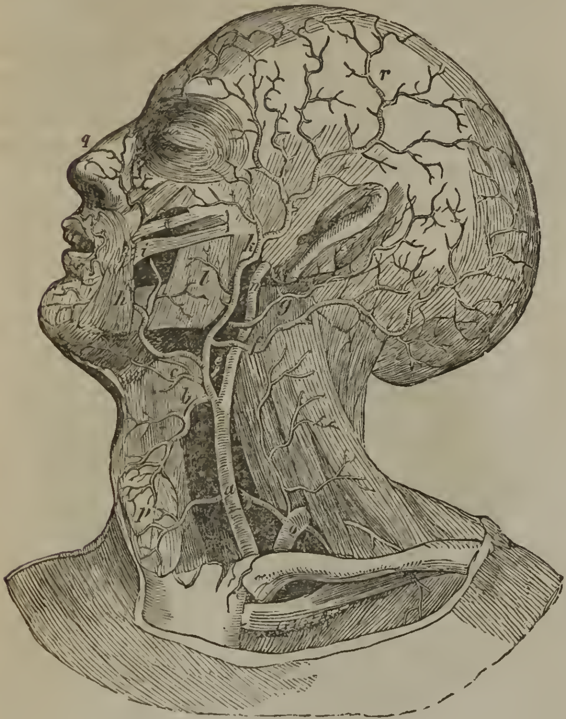
Explanation of Fig. 56.

a, *the heart*, in its natural position, the sternum being taken away, and the pericardium laid open in front, to give a full and perfect view of the organ; *c*, is the arch of the aorta, or primitive artery of the body, from which all others arise; *e*, is the *diaphragmatic nerve*, having its origin high up, on the side of the neck, and travelling down into the chest, on the outside of the *pericardium*, or heart-case, to reach the diaphragm, the partition that divides the chest from the abdomen. If this nerve is divided, all motion in the diaphragm will cease. It should be recollected that it is a muscle of respiration, rising and falling with the inflation and collapse of the lungs. The base, or rather under side of the heart, as it is suspended from above, rests on the diaphragm at the lower *b*; *b*, *b*, *i*, the heart-case; *d*, the *descending cava*, or great vein that returns the blood from the head and arms, into the right auricle of the heart.

ARTERIES.

To describe the arteries in a manner intelligible to persons who have never examined an anatomical preparation, in which these vessels are distended with wax, is certainly a difficult undertaking.

Fig. 57.



Explanation of Fig. 57.

By referring back to the plan of the perfect double heart, *i*, shows the origin of the *carotid artery*, a branch from the arch of the *aorta*. In this very accurate plan of the superficial arteries of the head, *a* is the continued trunk of the *carotid artery:* it is this vessel which is usually divided by suicides; it is this vessel also, with its mate on the other side of the

---

What are arteries?

neck, which, when compressed, causes apoplexy and death. *f*, the *occipital artery*, going to the muscles on the back of the head; *b*, is the *larynx*, or vocal box; *c*, indicates the place where the carotid divides into the *n*, the *external carotid*, branching onward; *b*, also is the *superior* thyroid artery; *p*, the thyroid gland, and inferior thyroid artery; *k*, the temporal artery, felt beating in the temple, and sometimes selected to bleed from in desperate cases; *o*, the left *subclavian artery; l*, the masseter muscle; *h*, depressor anguli oris, having running under it the external *maxillary* artery; *i*, the zygomaticus major, directing the eye also to the *coronary arteries of the lips; q*, the nasal artery; *r*, the termination of the temporal artery, in minute twigs on the top of the head.

After all that is said about the catalogue of arteries laid down in the human body, there is really *but one artery*, all others being branches from it. But to answer the purposes of the surgeon, it is absolutely necessary to treat of each twig distinctly, in order that its relation to other parts may be impressed on the mind of an operator.

Fig. 58.

Explanation of Fig. 58.

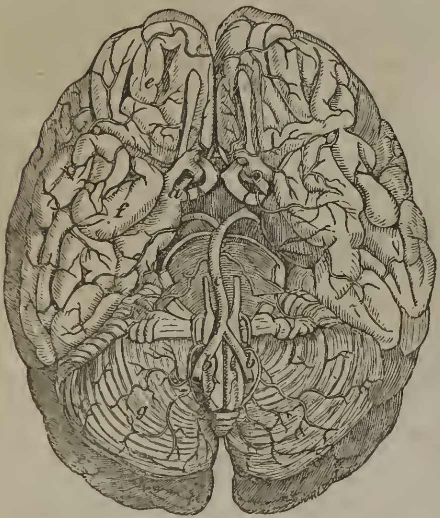
This diagram may be regarded as perfectly true to nature. The design is to show how the blood is conveyed to deep-seated muscles of the face, and to the membranes covering the brain, within the skull: all the vessels now under the eye are branches, originating from the trunk of the external carotid artery, shown in the preceding plan. *a*, is the *middle* or

great *meningeal artery of the dura mater*. By the side of the ear, lies the trunk of the *internal maxillary* artery, supplying a vast quantity of blood to the muscles of the face; part of the jaw and the process of the temporal bone is removed, to explain the manner of its course under and about them. *b*, a branch of the *inferior maxillary artery*, seen in the other plan: *c*, *posterior temporal branch*; *d*, *pterygoid arteries*, supplying those muscles which move the jaw in chewing; *i*, *buccal artery*, going to the buccinator, or trumpeter's muscle; *f*, *anterior deep temporal* branch; *e*, *infra orbitar artery*.

The bone in this figure is supposed to have been taken away, in order to exhibit the arteries *a* which branch, like the limbs of a tree, over the surface of the dura mater.

This one artery, the primitive trunk, is the *aorta*, rearing itself out of the left ventricle of the heart: collectively, the parent tube, with its subdivisions into thousands of tortuous pipes, is denominated the *aortic system;* and when arteries and veins are spoken of together, as a whole, the term *sanguiferous system* is used.

Fig. 59.



Explanation of Fig. 59.

This figure has been introduced to show the manner of supplying the brain with arterial blood by the *vertebral* arteries. It will doubtless be

What is the name of the primitive artery of the body?

What is understood by the aortic system?

recollected by the critical student, that in the lateral arms of the vertebræ of the neck, there were round holes, from one bone to the other. Through those holes an artery creeps securely into the skull, unexposed to the thousand accidents to which the carotid arteries are liable. If, for example, an operation requires that the carotids should be tied, so that no blood can pass in them, a supply for the brain is secured by these vertebrals. When they have arrived within the skull, at the under side of the brain, the two marked *b*, *b*, unite into one, which is *c*, and then branches off among the convolutions of the brain, indicated by the various letters; *g*, is the little brain or *cerebellum*; *f*, the middle lobe of the brain, or *cerebrum*; *e*, the anterior lobe of the *cerebrum*; and *a*, the *optic nerves*, or nerves of vision. This is no fanciful distribution of the arteries of this organ, but a perfectly true representation.

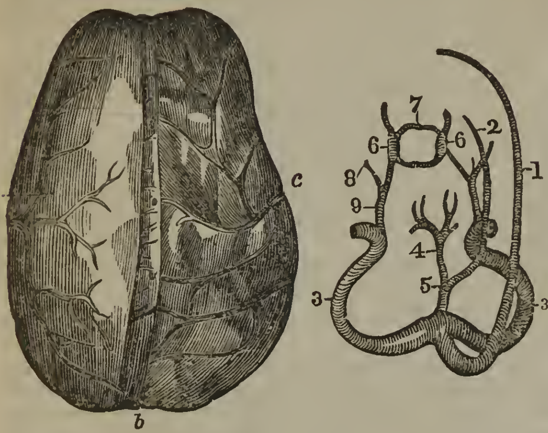
As the great cylinder rises above the top of the heart, thick, white and shining, it bulges out at the sides, in three directions, at the place where the three *semi-lunar valves* are fixed. The enlargement is known as the *sinus* of *Valsalvi*, from its supposed discoverer. Gradually it becomes smaller, preserving, however, a diameter equal to three fourths of an inch, till it gets above the heart, where it is gracefully curved over and upon the spine, down which it runs the entire circuit of the chest and abdomen. On the last joint, though not constantly, of the back, it divides into two trunks, to be sent to the inferior extremities. On the highest point of the arch, branches shoot off, to carry blood to the head and arms. Those going up the side of the neck are the *carotids*, the arteries which self-murderers divide in cutting their throats. It is by compressing these, as in hanging, that death is produced. When they arrive at the angle of the under jaw, they divide into *external* and *internal carotids:* the deep seated or inner ones go through an orifice in the bottom of the skull, to supply the brain; while the *external* creep up by the side of the ear, face, &c., supplying all the muscles and bones in the vicinity.

At the last joint of the spine, the *lumbar region*, we left the descending artery, divided into two branches. In ascending from the heart, the large artery is called the *ascending aorta*, and having made the curve, the descending *tube is the descending aorta*.

These two trunks, now lying just within the brim of the pelvis, divide again, sending a supply of blood to the muscles and apparatus within the pelvis. The first trunks are the *external iliacs*, and the second set are *internal iliacs*. Further down, in the thigh, in each limb, the arteries appear under the name of *femoral* arteries: in

the ham, behind the knee joint, the *poplitael;* still further, by the side of the shin bone, the *tibial;* in the foot,

Fig. 60.



Explanation of Fig. 60.

A very large quantity of blood, as we have seen, is sent to the brain, by four arteries, viz. the two carotids and two vertebrals. By this plan, it will be plainly understood how the blood gets back again to the heart. The *superior longitudinal sinus*, fig. 1, is nothing more than a vein, of a triangular shape, beginning within the skull, opposite the root of the nose, and going backward, between the bone and outer membrane of the brain, over the top of the head, increasing in size as it goes, till it reaches the level of the posterior lobe, where it divides into two canals, marked 3, 3. Many twigs of veins, pointed out by the other figures, bring the blood from other places in the head, but ultimately they all join one or the other branches of the main trunks of the sinus: 3, 3, are called *lateral sinuses*, because they are on the sides, as it were, of the head. These two trunks pass through a fissure, in the under side of the skull, between the temporals and occipital bone, and appearing by the side of the neck, are there called the *jugular* veins. The external jugulars return the blood from the face, &c., and finally join the internal jugulars, and there, by entering the chest, become enlarged by the union of the veins of the arms, when the whole are concentrated in one tube; that last one is the *descending vena cava*, emptying all the blood from the head, and brain, and arms, into the auricle of the right heart. The jugular veins, therefore, are the great veins of the brain, and commence behind the forehead bone, just between the eyes, within the skull.

the *plantar*; and so on, till the divisions become too minute to be discernible to the naked eye.

Between the arch and the pelvis, various little twigs are thrown off laterally to nourish the lungs, diaphragm,

liver, stomach, spleen, and other abdominal viscera, each bearing a name indicating its destination, or office, or supposed resemblance to familiar objects. Here, then, we have exhibited a scheme of the arterial system, perhaps quite as well as to have accompanied the text with many more drawings.

The arteries must be nourished themselves, by a free circulation of blood in their coats, as much as the heart; otherwise, were they independent of the rest of the living body, they would be extraneous, and could not contribute to its wants. On the sides of all the arteries, millions of vessels, infinitely fine, more nearly like the down on a peach than arteries, conduct a circulation. This tissue or net-work of miniature arteries is the *vasa vasorum.* Finally, the arteries are made up of several coats, as though one tube were thrust into another, which are muscular and membraneous, according to their importance.

As they recede from the heart; the tendency is to keep subdividing, to supply every possible part; hence, ultimately, they become too small to be seen. Between these points and the commencement of the veins is an intermediate set of *real* or *imaginary* vessels, the *capillaries*, through which the blood must pass to reach the veins. Such is the monstrous size of the aorta in a whale, that the whizzing velocity of the blood, at each systole, is audible to the harpooners: with the *stethoscope*, quite a modern invention, the rush of blood may be heard in our own chests.

That the arteries possess the property of contracting upon the blood cannot be denied. The heart, were it intended to force the column, independently of any assistance from the arteries, through their whole extent, we should suppose, was not adequate to the undertaking, because the proportions are unequal, in comparing the engine with the distance to which it is required to send the blood. The pulsations of the arteries indicate that they continue and propagate the action which was commenced by the heart.

Do the arteries themselves require a circulation of blood within their tissues?

What are capillary vessels, and where located?

Do the arteries possess a contractile property?

Fig. 61.

Explanation of Fig. 61.

It is utterly impossible, as well as unprofitable, in an elementary work of this kind, intended for youth, to picture every vessel; but we were desirous of displaying the arteries of the arm and palm of the hand, on account of the beauty and great importance of the structure. What is seen in this drawing exists in every living arm. Over the bend of the elbow, a mere web lies between the great artery and vein. The vein is taken away, but it will show how dangerous it is to bleed the vein at this point, on account of the nearness of the artery, which is liable to be wounded by the point of the lancet. A knowledge of this fact should deter every one from employing surgeons in whom they have not the most implicit confidence, that they understand anatomy. *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *k*, mark the branches of the *brachial artery* *a*, as they are, in relation to the muscles; *i* is the *fascia* or the membrane, between the *artery and vein*, and which is a tendinous strip sent off from the biceps flexor cubiti, or bending muscle of the forearm, as though it was expressly designed to confine the throbbing artery in its place, and protect it from the injuries to which it seems liable by carrying burdens in the arms. This strip of tendon is like the arch of a bridge, for if the arm is bent it is still tense, and therefore always a defence.

This brachial artery, near the elbow, divides into branches; one of them sinks into the muscles, to supply them, by the side of the ulna, on a line with the little finger, and hence called the *ulnar artery*. The

---

Point out the main artery of the arm.

How is the great vessel confined within the hollow of the elbow?

main trunk of the *brachial*, however, travels downward, quite superficially, near the edge of the *radius*, and therefore has the name of radial artery. In the wrist, being just under the skin, it is pressed against the bone, where its pulsations are felt: feeling the pulse, in the language of physicians, simply means the sensation conveyed by the throbbings of this artery, when thus compressed. Further on in the palm of the hand, it forms half a circle, termed the *palmar* arch, and from its outward curve *digital branches* convey the blood to the fingers and thumb.

Were it not so, of what use are the valves at the mouth of the aorta and in the pulmonary artery? If the volume to which an onward impetus had been given, could pursue the tortuous windings quite to the capillaries, of what need were the *valves?* The truth appears to be this, viz., the ventricle only throws the blood beyond the valves, which are thrust across the canal to prevent a regurgitation, and then the artery compresses it in turn. Onward it moves, to some other place, where, before the velocity that has been given it is lost, a second, third and fourth pulsation, as the case may be, completes the circle of action. Do we not actually feel that the artery pulsates in the wrist; and do we not also recollect, that in the fish, an artery, the *aorta*, assumes the office of a heart; in the vermin, too, did we not show that the aorta and accompanying arteries carried on the perfect circulation, without any heart at all?

The arteries are not passive tubes, imbedded in the concealed interstices of the muscles to conduct a fluid in which they have no part nor interest. They are not quiescent, like the logs of an aqueduct; they are portions of a living whole. They feel the vigor or the decay of other parts; they become diseased by over excitement; sicken, refuse to pursue their accustomed service; and when the crazy, shattered frame of the old man begins to tottle, the arteries, too, begin to flag, and finally cease to act at all. In old age they ossify, becoming perfectly bony tubes, for many inches together: by over action, they are enlarged into irregular sacks. or aneurisms; and in advanced cases, they burst, and the heart's blood is wasted so quickly, that life may be said to have exploded.

The tendency of age is to relax the muscular fibre; and in this general debility the arterial coats suffer, their diameters enlarge, and their power is diminished as their

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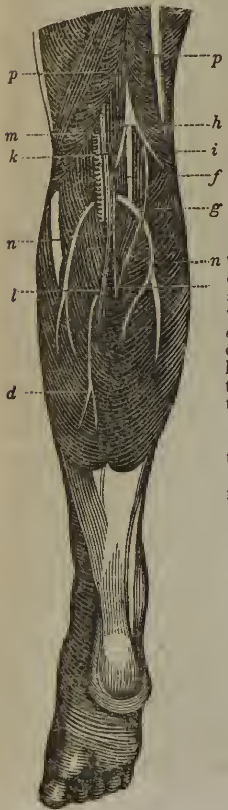
How far does the heart exert a projectile force on the blood?
At what period of life do the arteries become, in some instances, bony tubes?

transverse diameter increases. The energy of the pulse is lost; the arteries, however, make an effort to sustain their accustomed vigor, by assuming a more tortuous course, showing that the short curves which are made under these circumstances are favorable to the accumulation of physical power.

VEINS.

It is much easier to account for the propulsion of the blood from the heart, through the arteries, than to explain

Fig. 62.



Explanation of Fig. 62.

The anatomy of the veins being much less intricate than the arteries to understand, it has not been thought necessary to present more than one plan of some of the most superficial vessels of this order.

On the calf of the leg there are numerous veins, just under the skin, uniting into fewer and fewer branches, as they rise upon the limb, till they finally unite in two principal trunks, one deep seated, and the other superficial, which pass into the pelvis, at the groin, and thus convey the blood to the *ascending vena cava*, the great vein that carries all the blood to the heart, which has been collected below it. By turning to the drawing of the *double heart*, fig. 2, that great vein will be seen.

d, The gastrocnemius.

f, The branch arising from the popliteal.

g, The nervus communicans, arising from the fibular nerve.

h, The popliteal nerve.

i, The fibular nerve.

k, The popliteal vein.

l, The vena saphæna minor.

m, The popliteal artery.

n, *n*, The arteries distributed upon the calf of the leg.

p, *p*, The muscles on the back of the thigh.

d, The gastrocnemius.

the process of its return through the veins. Their origin is in the capillaries, quite at the extreme terminations of the arteries, growing larger as they advance towards the centre of the body. They are seen through the skin at the ends of the fingers, on the arms, and indeed everywhere, creeping upward, becoming increased in size at every step, till they eventually are reduced in number to two principal trunks, the superior and inferior cavas, at the right auricle. Their coats, which are the same as the arteries, are thinner and weaker, more dilatable, and consequently much oftener diseased and liable to accidents. Through their whole track, with a few exceptions, there is a line of valves, the office of which is to hold the column from falling back, that has once passed above the lock. So frequent are these valves, that they may be detected every inch, in the great veins of the arms. By compressing the vessel above one of them, the blood at once accumulates in the form of a knot, showing accurately the exact place of its locality. The principle of fixing a ligature round a limb, as a preparatory step to bleeding, with a lancet, is to stop the blood in its course, there being no possibility of its going backward, as it is held by the valve; therefore, as the canal is closed by compression above, the escape is at the incision.

We will not pretend to inform our readers how the blood travels up the veins, lying, as they do, perfectly quiescent. It seems as though there must be a propulsive force exerted somewhere in the vicinity of the capillaries, to thrust the blood along, yet dissection gives us no clue to the mystery.

The veins, acting as absorbents, accompany the arteries wherever they go.

CIRCULATION OF THE BLOOD.

Were it not necessary in the plan of animal life to present every particle of blood, at certain intervals, to the

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Can the return of the blood in the veins be readily accounted for?
Where do they originate?
Are they superficial?
Name the primary veins.
What is their structure?
Have they valves?
How can the place of a valve be ascertained?
What other offices do the veins sustain, besides returning the blood to the heart?
What is meant by the circulation of the blood?

influence of atmospheric air, there would have been no need of a heart. It might have remained undisturbed, fulfilling the intentions of its design. But it is secreted into the vessels to increase the growth, to repair the waste, and to sustain the whole by its vivifying presence. Every bone, muscle, tendon, nerve, membrane and fluid, *is made out of the blood.* As the parts to be made cannot fabricate themselves, and afterwards take their appointed stations, the blood goes to the spot [illegible]re this is to be effected, leaving material for a bone [illegible] place, glue to hold particles together in another, and so on, in its active round. But, on the other hand, these particles cannot fashion themselves: the poi[illegible]n artery, therefore, at which they are given off, moulds and finishes the work.

We here discover that the arteries possess a wonderful property, which was not spoken of in the preceding paragraphs. Industrious and unerring in all the first years of life, invariably conveying just the sort of material that may be wanted to mend a broken bone, to heal a cut finger, or to lubricate a joint: in forty years they fail to supply the eyes with sufficient quantities of humor to distend the ball; so we wear spectacles: they are forgetful of the order by which their early labors were regulated; lime is carried to the heart, where the valves become bony; stones form in the bladder; the teeth are not supplied with earthy matter in season to prevent their decay, and the hair becomes dry and falls off.

Such cursory remarks as these exhibit a bird's-eye view of the importance and multifarious functions of the arteries, and demonstrate the high value of the blood, from which so much and such inimitable machinery is formed.

As we now comprehend the use of the circulation, we will next endeavor to solve another apparently difficult problem, *why* it is necessary to throw the blood into the air cells of the lungs.

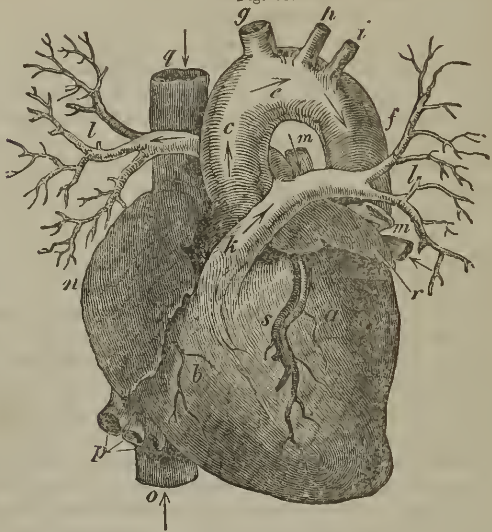
The sign of vitality of the blood is its scarlet color, which it only exhibits in the heart and arteries. When it goes from the heart, it is charged with the presence, or admixture, of every material which can possibly be required; but on its way to the capillaries, all these several

---

Why is it necessary that this fluid should circulate?
How happens it that the valves become ossified?
Does the blood pass into the lungs?
How is the arterial blood distinguished from venous?

materials, supposed to be in solution, are dropped on the way, so that when the refuse, that is, the fluid, which was

Fig. 63.



Explanation of Fig. 63.

If the student is desirous of thoroughly and clearly understanding the circulation of the blood, as it moves in his own body, let him now recapitulate the subject, by following the *venous* or black blood from the two great supplying veins, till it arrives in the main distributing artery, purified, re-vitalized, and in a condition to sustain animal life.

q, the *descending vena cava*, returning black blood from the head and upper extremities.

o, the *ascending vena cava*, returning the same kind of blood from the lower parts of the body.

n, the right auricle of the heart, where both veins meet.

p, and *x*, veins from the liver, spleen and bowels, uniting with the *inferior cava*.

The auricle, being filled, contracts and forces the blood into *b*, the ventricle: next the ventricle contracts and sends it into *k*, the *pulmonary* artery, which branches into *l*, *l*, to supply the lungs in both sides of the chest. From the lungs, where a scarlet color has been given it, four veins of the lungs gather it together, and deposit it in the *left auricle*, *r*; that contracts, and the blood is driven into the *left ventricle*, *a*; lastly, the ventricle contracts and throws it into *c*, the *aorta*, which conducts it over and through every bone, muscle and organ.

Under a solar microscope, the circulation of the blood in the thin web of a frog's foot, and several other reptiles, may be distinctly observed; and in insects, while they remain worms, the pulsations of the artery, which acts instead of a heart, are readily perceived. In the oyster, the heart pulsates about thirty-seven times in a minute.

Before birth, the blood, instead of going from the auricle of the right heart down into the ventricle, to be thrown into the lungs, passes directly through a valve in the partition wall between the two auricles, and thus gets into the left side or left heart. The reason why the blood is not sent to the lungs, is because they have not yet assumed the function of breathing. At birth, when the first breath of air is inhaled that ever enters the lungs, the valve closes up the opening forever, and the blood then takes a circuitous route through the lungs, for the reason which has been already so familiarly explained.

merely the medium of conveyance, enters the extreme beginnings of the veins, its color is almost black.

Having, therefore, imparted all its needful qualities, it is totally unfit to be sent round a second time, till it is re-charged. To obtain this quality, now lost, the *right heart* sends it into the lungs. Surrounding each distended air cell is a thin sheet of black venous blood, which, by the mysterious influence of the contained air, changes the color, instantly, to its original *scarlet*. The orgasm, the suddenness of the change, cannot be conceived; yet the whole mass is re-vitalized, and is now carried into the left heart, to be sent over the old ground.

Anatomists, treating of this fluid, speak of its being composed of *serum*, the watery, yellowish fluid; *fibrin*, the *crassamentum*, or cake; and the coloring matter. Were we not restricted in this work to certain limits, it would certainly be an entertaining theme to detail the extravagant whims which the old authors entertained upon the subject of the red globules of the blood. It actually seems, to a calm spectator, who surveys the past and compares it with the present, as though the physiologists of the two last centuries bowed down to make themselves positively ridiculous, by the sweat of the brow. When, by some fortuitous circumstance, it was ascertained that the florid hue of the blood depended on the actual pressure of floating globules, of different sizes, yet so minutely small as to appear like the coloring of an infusion, they set to work in earnest to investigate their use and structure. About the same time, unluckily, a philosopher invented the compound microscope, which enabled every body to peep into microcosms, where they beheld sights, quite imaginary in most cases, more astonishing than were ever before revealed to human eyes.

Whether they saw distinctly or not, it is now of little consequence; but, at all events, they asserted the want of

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Of what is blood composed? Has it a coloring matter?

uniformity in the size of the globules, though each one was a *hexagon*, built up regularly and mathematically, as an architect could construct a country seat, of *six smaller hexagons!* However small,—and some were supposed to be immensely beyond the magnifying reach of their glasses,—they were all framed in the same workmanlike manner.

All this fine discovery being settled and indisputably admitted,—for it would have been outrageously impolite for those who had no microscopes to call the marvellous discovery in question,—their wits were in labor to devise a rank for them in the circulation. This, too, was accomplished; but to find out the diseases that originated in consequence of the mistakes or refractory conduct of the compound balloons, was a poser. There is nothing, by the way, like perseverance. A man who is lost in a fog has but one course to pursue, and that is to take care of himself: so it was with our discoverers; they had their mathematical bladders on hand, which must be disposed of; and here they are, in all their beauty of arrangement, from the plastic hands of their discoverers.

Diseases were the effects arising from *error loci*—that is, some of the large globules, fitted to the calibre of a particular artery, got wedged, by some sad mishap, at the mouth of a smaller vessel, or, becoming angry, refused to operate in the harness, so puffed up, clogged the passage, and this produced *inflammation*, out of the modifications of which fevers, dropsies, and all the other ills that flesh is heir to, had a bona fide origin!

Enough has been written to stimulate our readers to the perusal of the old records of physiological folly, in the original tongue, if they wish for an uninterrupted history of that singular discovery. To those who are more interested in the anatomical facts we have been relating, touching the heart and the arteries, it is needless to recommend them to the writings of those who are teachers by profession. Perhaps we may have committed ourselves in the ardor of the moment, by advancing ideas quite as absurd as those which we have been condemning; but in the demonstration of parts we are conscious of being right, having given the anatomy of the circula-

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What was the opinion of the ancients in relation to the physiology of the blood?

tion as we have found it by years of toil; and as it regards theories, things made at little expense, like castles in the air, we are not tenacious about the respect that may be paid to them.

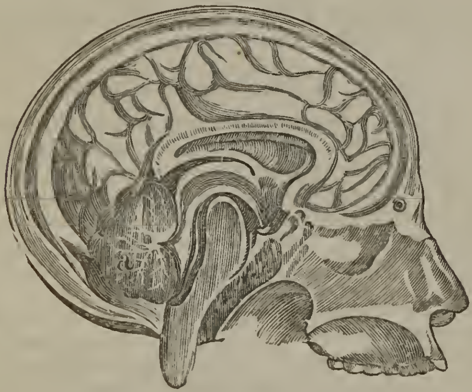
THE NERVES,

OR NEUROLOGY.

Neurology teaches us the anatomy and physiology of the nerves.

The brain is the radiating point whence the nerves, to a considerable extent, have their origin. The spinal marrow, from which an immense number of nerves branch out, is considered in reality by some a prolongation of the brain itself. Phrenologists, on the other hand, suppose the brain arises from the spinal marrow, because the brain is sometimes wanting, but the nerves are always present.

Fig. 64.



Explanation of Fig. 64.

This is an exhibition of a vertical section of the bones of the head, face and brain, showing precisely the appearance, were the head divided in

What does neurology teach? What organ is considered the centre of the nervous system?

the middle, from the top down to the neck. No letters of reference have been introduced, because the plate will be doubly valuable, when the general relation of the different portions have been learned from the text and the other diagrams. The reader will then trace with his eye the outline of the little brain, the *cerebrum*, or large brain, the seat of thought; the ventricles and other interesting points, which, though intricate, are nevertheless worth the trouble of understanding. The mechanical arrangement is only contemplated in these illustrations: the functions of the brain, in a treatise purely elementary, would be wholly useless.

In the first place, the contents of the head are divided into the *cerebrum* and *cerebellum*, or, in other words, the *great* and *small* brains. Above the level of the ears, all the upper portion of the skull is occupied by the *cerebrum*, which is the immediate seat of intellect. Below that level, in the lower and back part of the head, is the *cerebellum*, or little brain. They are separated from each other by a membrane, tensely stretched. Otherwise, the weight of the upper mass would oppress the functions of the lower one. By a vertical line, the brain is divided into *hemispheres*, as right and left; but when it is dislodged from the head, and inverted, the under side presents three prominent risings, which are denominated *lobes*. Those portions of the brain directly behind each eye are the *anterior lobes;* those at the back side of the head, the *posterior;* and the third, between them both, are the *middle lobes*.

COATS OF THE BRAIN AND NERVES.

In this plain exposition of the anatomy of the nervous system, it would be an endless labor to attempt a minute detail of the three different coverings which surround the intellectual apparatus, independently of the bony box, the strong wall that envelops the whole.

FIRM COAT, OR—*Dura mater.*

When the skull is opened, a dense, shining membrane is presented, that keeps the brain together, when the bones are taken entirely away. Completely embracing the entire organ, it becomes thicker round the *medulla oblonga*, to defend this narrowing of the brain over the

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How is the brain anatomically divided?
What part of the brain is called the cerebrum?
Where does the cerebellum lie?
How many investing membranes has the brain?
Describe the dura mater.

bones of the neck, then continues its course through the whole length of the back bone, embracing the marrow. Wherever a branch or side nerve is given off, a portion of the dura mater follows it, precisely as the bark of the trunk covers the branching limbs. In the still smaller divisions of the nerve, a continuous tube of the dura mater is found, till both are finally lost on the exterior surface. This membrane defends the pulp of the nervous matter within its embrace, wherever the nerves may traverse.

TRANSPARENT COAT, OR—*Tunica arachnoides.*

Perhaps there is not a more delicate, transparent membrane in the whole body than this, so much resembling a spider's web, that from this circumstance it has its name. This lies over the convolutions of the brain, directly under the dura mater, and does not dip down between the prominences. Beside surrounding the brain, like the other, it has precisely the same infinite distribution, making the second tube for defending the nerve.

SOFT COAT, OR—*Pia mater.*

Blood must be everywhere freely circulated; but in the brain it is necessarily thrown into that portion which is the seat of thought in very minute, hair-like currents, otherwise the force of the heart, which acts upon the principle of a forcing-pump or syringe, would tear it to pieces. This pia mater, therefore, is an immense, broad, thin net of blood-vessels, following the fissures and winding into the very centre of the brain, and also pursues the nerves wherever they may go, always in attendance to furnish the vital fluid, on which health, sensibility, and, indeed, all the vital functions are forever depending.

STRUCTURE OF THE BRAIN.

The centre of the nervous system is the brain, within the bones of the head, with the exception of that class of animals which, as it were, are the uniting links between the vegetable and animal kingdom; the worms are without it: fishes too, and amphibious reptiles have scarcely

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What names have, and where are the other tunics? The use of the pia mater?

a development of the nervous mass, entitling it to the appellation of brain. We suppose, however, that we are contemplating the human brain, a singular, but splendidly constructed piece of mechanism, made up of an infinite congeries of delicate cords, and equally attenuated blood-vessels.

It was once thought that we had but one brain, but modern discovery assures us that we possess four, and that two of them mutually coöperate, in function, with the others.

There is no particular point where the brain can be said to begin, nor a point, in fact, where it terminates. Let the reader suppose that on the first joint of the neck, just under the head, two large cords are lying, side by side: entering the great natural opening of the skull, they are subdivided into millions of threads, portions of which assume different forms, to which anatomists give specific names, as cruri, pons, &c. But as the threads are merely subdivisions of the one cord, the mystery is, at first view, how comes such an increased quantity? Nothing is more simple than an explanation. Admitting the fibres to be indefinitely long,—the folding and refolding of one upon another, in conjunction with an artery and vein,—there is no difficulty in giving an answer. For the evidence of a fibrous structure, this infinite volume of threads, we refer to the positive demonstration of the brain by the late Dr. Spurzheim.

Most of the organs are double, and it was highly necessary that the brain should be so also. The great brain, *cerebrum*, in the upper part of the head and over the eyes, is the immediate seat of intellect, and in halves; in other words, there is one on each side, divided above from each other, in the middle, by a membrane. Under this, in the lower and back part of the head, is the *cerebellum*, or little brain, belonging to the animal system, and totally different in function from the other: this, too, is in two pieces.

Below the point on the neck bone on which the two lateral cords, termed *medulla oblonga*, lie, extending within the bones, the whole length of the spine or back bone, the same cords are seen, giving out between the points, ribs, &c., branches, called *spinal nerves*. Those within

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What is the general structure of the brain?

the chest take the name of *thoracic nerves;* still lower, between the ribs, *intercostal;* and still further down, between the bones of the back, the *lumbar nerves.* The limbs of a tree, shooting out from the trunk, precisely represent this part of the anatomy of the spinal marrow.

From the head to the termination of the spinal marrow, *two cords, two brains, two little brains,* and *two distinct sets of lateral nerves* exist, lying in juxtaposition, intimately united by the decussation of fibres, which run from one to the other.

This cerebral substance is so soft, that without its enveloping membranes it would fall to pieces by its own weight. These membranes possess but a very slight degree of sensibility, being of a mealy whiteness, and in the skull possessing but little elasticity, though in the body and limbs this quality necessarily exists, or they would become elongated and flaccid in the constant flexions of the extremities.

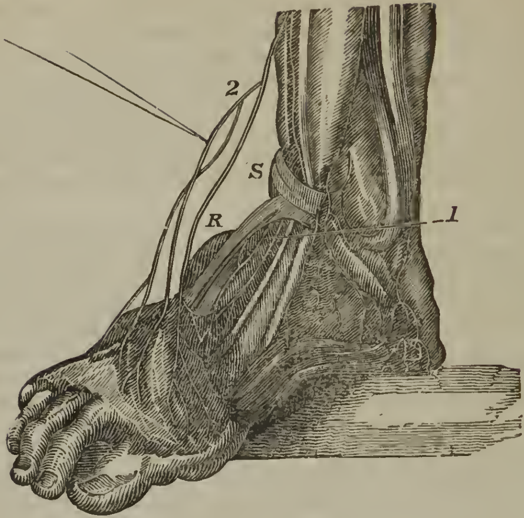
Whilst this nervous matter preserves its vitality, it preserves a slight degree of cohesion, but after death it speedily begins to decay, and ultimately melts down into an oily fluid. The compositions of the pulp of the nerves and the brain are precisely the same in appearance in life, and chemical analysis conclusively presents the same elements after death.

When wounded, even badly, the brain feels no pain, although the very centre of sensation. It is not uncommon for portions of the brain to escape through fractures of the skull, and yet the person perfectly recover, and never suffer, in any quality of his mind, from the loss of this important corporal substance.

All the nerves which go from the head or spinal marrow, however much they may be distributed within the muscles, invariably run towards the surface of the body. They do not end in blunt extremities under the skin, like the cut end of a twine; on the contrary, they are so infinitely subdivided, that the single cord which we find between two points of the spine may finally become a perfect brush, in the course of distribution, and lost in the masses of flesh through which it travels, till it can no longer be recognised by the naked eye.

From whence originate the nerves? What is their course? Have the cerebral membranes sensibility?

Fig. 65.



Explanation of Fig. 65.

S, the annular ligament which binds down the muscles and vessels to the ankle bone, to keep them in place. *R*, the *extensor brevis digitorum*, which assists in extending the toes. Fig. 1, superficial threads of the deep-seated nerves of the leg and instep, emerging upon the top, and losing themselves in the skin. Fig. 2, are long, but superficial cutaneous branches of the tibial nerve, sent into the skin and cellular membrane at the root of the toes and ball of the great toe. The trunk, from which these twigs have their origin, originated within the pelvis, yet, notwithstanding they were concealed deep in the flesh, the whole length of the limb, they finally make their appearance at the surface. This figure, therefore, is designed to illustrate the position maintained in the text, viz., that all the nerves have a direction towards the external surface of the body.

THE MECHANISM OF THE NERVES.

As the brain, all experience proves, is the seat of intellect, so, also, incontestable evidence teaches us that the nerves are parts which are susceptible of painful or pleasurable sensations. Thus a piece of sugar is grateful to the gustatory or *tasting* nerves of the tongue; but tobacco, before accustomed to its nauseating character, has

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Where is the seat of intellect?

a directly opposite effect. Pressure on the *sciatic* or great nerve of the leg, by sitting too long in one position, produces the disagreeable feeling commonly called *sleep in the foot;* if, however, the attitude is not changed, to relieve the pressure, a partial palsy of the limb must ensue.

Difficult as it is to ascertain precisely the structure of the inner substance of the nerves, it is reasonable to infer, from analogy, as the substance is so exactly like that of the brain, that they are constituted of a multitude of minute, soft, pulpy parallel cords. Instead of saying that the nerves have their origin in the brain or spinal marrow, they should be called the prolongations of the brain. Their internal substance, both physically and chemically considered, presents the same results. They are the tentaculæ of the brain, analogous to the feelers of insects, by which it takes cognizance of external things: the instruments of the will, and the ever faithful sentinels at the outposts, giving the earliest and most certain intelligence of whatever is of consequence to the safety and wellbeing of the individual.

If they possess an organization like the brain, or, in fact, are simply a prolongation of it into the extremities of the limbs, the question may be asked, why they are not conscious in their individual capacity, and why it is necessary to make reference to the superior mass of the same material, within the skull.

In the very lowest orders of animals, such is the case, to a certain extent: the worms are without brain, yet they pursue unvarying instinctive actions, and avoid enemies, or caress friends, with as much certainty as those possessing a well marked one.

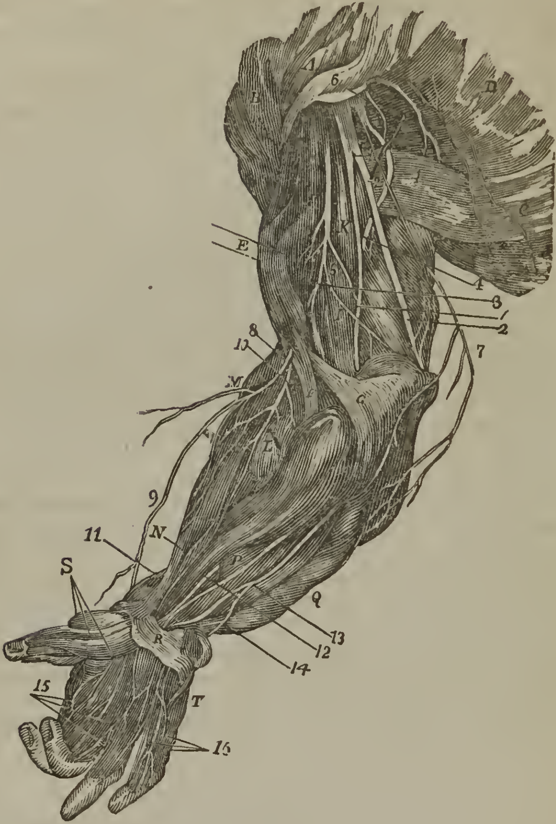
Nothing can be more perplexing than the nerves, being of all sizes, from a quarter of an inch in diameter to hair-like threads, invisible to the naked eye.

Certain it is, that this apparent confusion presents the same appearance in all animals of the same species. Wherever there is a twig in one body leading to an organ, precisely such another, fulfilling exactly the same office, may be demonstrated in another. A curious illustration of this remark is strikingly manifested in the nerves of the human hand.

Are the nerves in composition like the brain? Have worms a brain?

The arteries are not invariably constant, or undeviating travellers of a particular muscle. With the nerves the

Fig. 66



Explanations of Fig. 66.

MUSCLES.

A, *Pectoral muscle.*
B, *Deltoid muscle.*
C, *Latissimus dorsi muscle.*
D, *Serratus major anticus muscle.*
E, *Biceps flexor brachii.*
F, *Round tendon of the biceps*, crossing the elbow joint.

G, The broad expansion of the *biceps*, shooting into the *fassia* of the fore-arm.
H, *Triceps extensor muscle.*
I, *Brachius internus muscle*, an auxiliary to the *biceps*.
K, *Coraco brachialis muscle*, an assistant to the *deltoides*.
L, *Supinator brevis muscle*, turns the palm of the hand and fore-arm forward.
M, *Supinator longus*, operates in unison with the *brevis*.
N, Extensor radialis longior, extends the fore-arm.
O, Many flexor muscles of the fingers, all arising from one point.
P, *Flexor digitorum profundus*, bends the joint of the fingers.
R, *Annular ligament* of the wrist, bending the tendons in a groove.
S, Short muscles, forming the ball of the thumb.
T, *Flexor and abductor* muscles of the little finger.

NERVES.

1, 1, Radial nerve.
2, 2, Ulnar do.
3, External cutaneous nerve.
4, Muscular spiral nerve; supplies the flesh on the back side of the arm and skin.
5, A communicating twig.
6, Articular nerve, round the joint.
7, Internal cutaneous, supplies the skin under side of the arm.
8, External cutaneous, again; passing through a muscle, and then becoming a cutaneous nerve.
9, Branch of the external, going to the back of the thumb.
10, Muscular spiral nerve.
11, A branch of the *external cutaneous*.
12, The *radial nerve*. } Different views.
13, The ulnar nerve. }
14, A branch of the ulna, to the back of the hand.
15, Distribution of the *radial nerve* to the thumb, fore finger, middle and one side of the ring finger.
16, Distribution of the *ulna nerve* to the other side of the ring, and both sides of the little finger.
N. B. We have exhibited in this plate a mass of muscles and nerves, that the reader may have some idea of the complex machinery necessary to the perfection of one single limb.

case is altered: they are constant, as it respects the origin, course, and ultimate distribution. Go where they may, a precise number of branches are required, to be distributed to every portion and piece in which a blood-vessel enters. Usually, the deep-seated nerves accompany the arteries; and the nerves of the skin keep in the track of the superficial veins.

Though the nerves are small, and uninfluenced by volition, exact order is preserved, or the same effects could not be produced in two individuals from the same causes.

Are the nerves distributed alike in every person? What vessels do they accompany?

Without nerves there could be no sensation: without them, neither painful or pleasurable emotions would be recognised; without them, organized beings would be completely motionless, without locomotion, and without perception or consciousness.

It matters not how perfectly the muscles are developed, or advantageously arranged; if there were no mode of subjecting them to the influence of the brain, they would be of no kind of consequence.

Were the nerves in the wrist divided, the ability to clench the fingers would be lost; nor could it be recovered, unless a re-union of the divided portions were effected. These are the voluntary nerves.

Those denominated *involuntary*, administering to the involuntary muscles, are equally important to the hidden regions in which they are found. When the breathing nerve of the diaphragm is separated, the midriff no longer renders assistance in respiration. The muscles of the chest are compelled to carry on the process of breathing entirely alone. By dividing minute twigs, as they creep into the vocal box of a dog, the muscles are paralyzed, and the animal can never afterwards bark.

Digestion in the stomach may be interrupted by cutting the main trunks of the nerves. Even the functions of the liver and kidneys might be checked in the same way, were it possible to reach the nerves going to them, without violence.

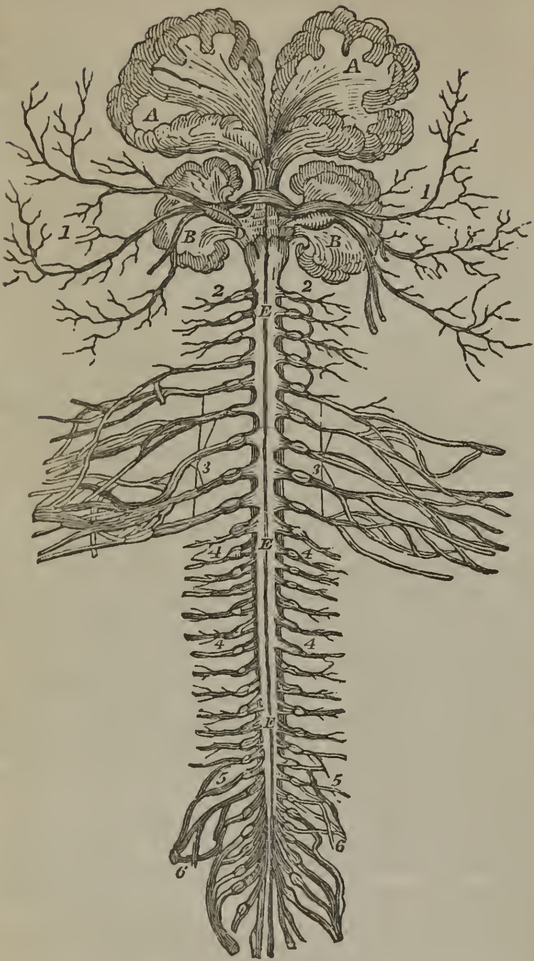
Notwithstanding the heart is kept in continual motion by the presence of the blood, if its nerves were separated, so that the communication were interrupted with the brain and spinal marrow, it would cease to pulsate, though its irritability, an original endowment of the muscle, might remain a considerable time. And still further, a wound or compression of the spinal marrow completely paralyzes the whole body, which, if not speedily relieved, ends in death.

For the sake of method, anatomists have made a regular classification of the nerves:—

From the brain, there are nine pairs, a majority of which are the nerves of sense; in other words, they are expended on the organs of sense, as the ear, eye, nose, and tongue.

What nerves are voluntary? Are the nerves classified?

Fig. 67.



Explanations of Fig. 67.

A, A, *Cerebrum*, or brain.
B, B, *Cerebellum*, or little brain.
C, C, *Crura cerebri*, or union of the fibres of the brain.

D, D, *Crura cerebelli*, union of the two sides of the little brain.
E, E, E, *Spinal marrow*.
1, 1, Branches of the 5th nerves, so often noticed in this work.
2, 2, Branches of the *sub-occipital nerves*.
3, 3, Branches of the four inferior *cervical nerves*, and the first *dorsal*, forming the *axillary plexus*, from whence all the nerves of the arm and fingers have their origin.
4, 4, 4, 4, Branches of the *dorsal nerves*.
5, 5, *Lumbar nerves*.
6, 6, *Sacral nerves*.

Issuing from between the bones of the neck, there are eight pairs; from between the joints of the spine, twelve; from the loins, five pairs more; and from the sacrum or last bone of the vertebral column, five more; making a total of thirty-nine sets of nerves, from the brain and spinal cord.

THIRTY PAIRS OF SPINAL NERVES.

These are first divided into *Eight pairs of Cervical*, coming out between the bones of the neck, on either side, from the spinal marrow, to be distributed to the muscles.

Twelve pairs of Dorsal,—in like manner, coming out between the dorsal vertebræ of the back.

Five pairs of Lumbar,—from between the lumbar or joints of the loins.

Five pairs of Sacral,—being a branch or termination of the spinal marrow *in the os sacrum*. Several cords. coming through the several openings, unite to form the great *sciatic nerve* of the leg.

Another circumstance should not be lost sight of in this general survey of these organs:—viz., the well established fact, that two threads may arise from the same root, and yet they sustain widely different offices in the economy: one may contribute to the contraction of a muscle, and the other its relaxation.

We are warranted in believing, that even in a minute nerve, which appears a single cord, that a number of distinct parallel filaments are lying side by side, enveloped in the same tissue, whose functions are widely different from each other.

Of the nine pairs of nerves from the brain, let us pursue them to their ultimate destination, not, however, with the

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How many pairs are given out from the brain?
How many from the spine?
How many from the loins?
Can two functions be performed by one nerve?

vain expectation of ascertaining how it is that they exert an influence, but simply to contemplate the broad chart of sympathies which is thus spread for distributing and controlling that vitality which is so essential to order, to consciousness and to physical perfectibility.

First, the *olfactory* nerves, taking their rise in the brain, having gone but little way within the skull, arrive at the top of the nose, where they suddenly divide into innumerable hair-drawn threads, which are lost in the lining membrane of the nose.

The second are the *optic*, expanding, when they have penetrated the globe of the eye, through the back side, into a thin web, properly named the *retina*, which is the seat of vision.

In this instance, arising from the same substance as the olfactory to all human appearance, is a nerve which can only be influenced by the presence of light.

When the nervous system is agitated by disease, even in the darkest apartment, the participation which the optic nerve has with the diseased action of the whole, produces the sensation of vision, and nothing else. If it cannot be the bearer of this one item of intelligence, it can do nothing at all. If another sensation is to be conducted to the mind, even if it relates to a mote on the face of the eye, another set of nerves, entirely independent of the *optic*, must be the bearers. There is no property in common; no relationship allowing the one to perform the functions of the other; yet they both seem to possess the same general structure, the same component parts, and have an origin from the same fountain-head, and depend for their vitality upon the same circulation.

The third nerve is generally distributed to the muscles of the eye, to give guidance to several of them.

Further; the fourth nerve, arising from the brain, long, slender, and hair-like, is dispensed altogether upon one muscle, the one which rolls the eye downward towards the shoulder.

The fifth nerve is the most intricate to understand. Lying almost in contact with the great artery of the brain, in the base of the skull, the single cord spreads

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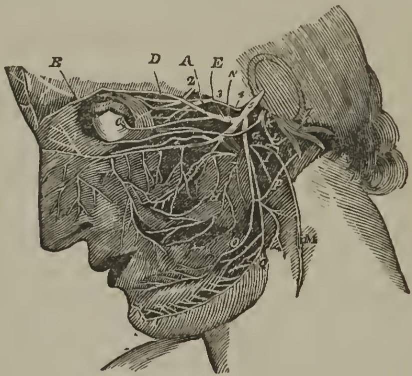
Where are the olfactory nerves? Give the name and distribution of the second pair of nerves. What nerve is particularly intricate?

itself out into the form of a reddish, fleshy pad, from which three distinct cords, all distinguished for their size, have an origin. One of the three darts towards the eye, where it commingles with those we have been describing. The second branch creeps through an orifice, and having reached the back part of the upper jaw, sends on a lash of fine lines, which find an entrance into the substance of the bones, and there furnishes the root of each tooth with one of them.

Fig. 68.



Explanations of Fig. 68.

This plate will give some general idea of the intricacy of the nerves about the face. The most difficult part of the neurology of the head is concealed by the bones, though we have adverted to the individual nerves, which have their origin in the brain.

2, The *optic nerve*, nerve of vision, second in the order.
3, *Motor oculi*, or third pair, arising from the brain.
4, *Trochlearis*, fourth pair.
5, *Trigemini*, with its three great branches, spoken of in the text.
A, First division of the fifth nerve, called the *opthalmic branch*, which divides again into—
B, The *frontal* nerve.
C, The lachrymal nerve.
D, The nasal nerve.
E, Second division of the fifth nerve.
F, That branch of it going to the teeth and skin of the upper jaw.
G, A ganglion.
H, Branches going to the palate and throat.
I, *Videan* nerve.
6, Sixth nerve of the brain.
K, Origin of the *great sympathetic nerve*, spoken of in the text.
L, Its additional branch, from the *Videan* nerve.
M, Superior or first *ganglion* of the sympathetic nerve.

N, *Third* division of the *fifth nerve.*
O, First division of the third branch of the fifth nerve, going to the tongue. This nerve is the organ of taste.
P, A branch of the *gustatory*, or tasting nerve, going to the ear and crossing the drum.
Q, That division of the fifth nerve which supplies the teeth of the under jaw, and finally comes out on the chin, to supply the muscles of expression.
7, Seventh pair of nerves from the brain, or auditory, being the nerve of hearing.
Perhaps, with all our care, the reader will scarcely understand the scheme which has here been presented. It is not our object to be so minute as to weary, and yet we desire to be sufficiently particular to be useful.

The third branch makes its way out of the head, and directs its course to the inner side of the angle of the under jaw, where it enters a smooth canal, and in like manner furnishes each of the fangs of the under teeth with a minute nerve.

A recollection of the origin of the dental nerves will explain the reason why a sound tooth in the opposite jaw sympathizes with the pain of a diseased one.

To the eye, again, the *sixth* nerve goes. Such a liberal supply of nervous influence as is thus given to this one organ, argues very clearly its importance. In no other portion of the machine is there a parallel distribution of nerves.

The *seventh* is a double nerve: two cords, quite in contact, the one hard and the other soft, strike the extremity of that portion of the temporal bone, within the skull, containing the beautiful apparatus of the ear. One of them is expended upon the inside, and is the acoustic nerve: the other pays no regard to the ear, but, working through the solid bones, shows itself on the cheek, very near the middle of the external ear.

What circumstance of organization prepares these nerves, arising, if not at the same point, at least from the same mass, for performing such opposite functions, as hearing and feeling, must long remain an inexplicable paradox.

Still further in the series comes the *eighth* pair, or *par vagum*, sliding out at the base of the skull, in company with the internal jugular vein. Coursing down the side of the neck, it dips into the chest, running through its

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From what nerves do the teeth receive twigs?
Use of the seventh pair?
What course has the eighth?

whole extent, and finally shows itself in the cavity of the abdomen. From its first exit from the brain, it drops off twig after twig, nearly at right angles, for the superficial muscles on the throat, and the vocal tube; to the larynx; to the wind-pipe; the lobes of the lungs on either side; to the heart; the great blood-vessel of the body; to the stomach, liver, spleen, kidneys; and, to all appearance, neglects no viscera in any of the great cavities. No other nerve, but the sympathetic, seems to have such extensive relations, nor is any one of more consequence to organic life.

Reflect, for a moment, on the extraordinary offices of this one nerve. Both vessels and muscles, on its first appearance, mutually depend upon its influence. Next, a class of involuntary muscles within the vocal box cannot be varied in their contractions without its presence. Even the vibration of the vocal cords, the instruments of voice, would be unserviceable without it: the lungs, stomach, liver, and the intestinal mechanism would stop, and a universal failure of all the vital apparatus would inevitably ensue.

One more—the *ninth*—the *lingual nerve*, closes the series from the brain. Without it there would be no ability for moving the tongue.

Let us re-examine the scheme of the nerves arising from the spinal marrow.

That prolongation of the brain, which lies in the canal of the spine, gives out two sets of nerves, as from the two sides of the brain, but vastly larger in size. Besides being large, several of them unite together so closely that it is really difficult to separate them, for the purpose, it is supposed, of establishing a wide circle of sympathies, and a combination of influence upon the muscles. Notwithstanding the apparent confusion, the most exact order is maintained.

No man has been competent to an explanation of this complex mechanism. Though emanating from a condensed part of the brain, in which the intellectual operations are not admitted to be in force, a class of nerves have an origin, which are under the most complete sub-

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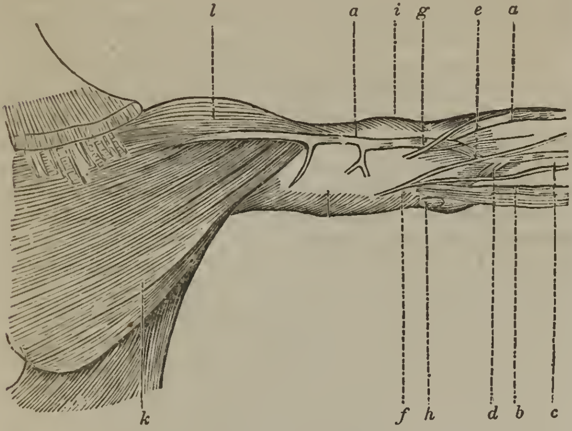
With what viscera does it hold an intimate connexion?
To what organ is the ninth pair given?
From whence have two distinct sets of nerves their origin?

jection to another portion of the same substance. So it is in respect to all the dorsal, lumbar and sacral nerves.

Fig. 69.



Explanations of Fig. 69.

This plan shows the distribution of some of the nerves of the arm.

a, a, The cephalic vein, running between the pectoralis major and deltoid muscle.

b, The basilic vein.

c, The vena mediana longa, sending off.

d, The median basilic vein.

e, The median cephalic vein.

f, The internal cutaneous nerve.

g, The external muscular cutaneous nerve.

h, A lymphatic gland.

i, The fascia covering the muscles of the upper arm.

k, The pectoralis major.

l, The deltoid muscle.

These considerations are curious in themselves, and in the mechanic, the scholar and the philosopher, excite an ardent desire to comprehend the reason for the one, and the cause of the other. All the boasted and lofty pretensions of philosophy are inadequate to the solution of these problems in the laws of the animal economy.

GREAT SYMPATHETIC NERVE.

As a point of union between the nerves of the brain and those of the spinal marrow, to maintain a sympathy

of connexion between the voluntary and involuntary organs, is interposed the *sympathetic nerve*, which traverses the whole extent of the chest and abdomen, sending fibres in all directions, to every viscus in the body. Thus, by this one nerve, a mutual dependence is preserved among all the various portions of the living system.

Nerves are certainly the organs of our senses. How, by the application of bodies to the different parts, a sensation is produced, will never, we fear, be clearly explained, nor can we account for a corresponding change in the brain, to produce an idea. Neither is it known how sensation is conveyed by the nerves to the brain.

Sensation is a property peculiar to the nervous fibre, as irritability is to the muscle.

THE SENSES.

The senses are divided into *internal* and *external*. The internal are *ideas*, which the mind forms, and may be produced by the agency of the external senses, or otherwise excited, as *memory*, *imagination*, *conscience*, and the *passions*.

EXTERNAL SENSES.

Hearing, Seeing, Feeling, Smelling, and Tasting.

THE EAR.

The ear, that organ by which we are made sensible of the impression of sound, is a very complicated instrument, and a beautiful piece of mechanism.

It is a curious circumstance in the economy of organized beings, that the central portion of the human ear, termed the *sacculus vestibuli*, hereafter to be described, is the basis of the apparatus of hearing in all animals, with

Do you recollect the office of the sympathetic?
What is the use of nerves?
Where is the seat of sensation?
How are the senses arranged?
Name the external senses?
Give a definition of the ear.

the exception of insects, but becoming more and more complex as inferior grades approximate the physical perfectibility of man.

Sound being a vibratory motion of the air, first put in motion by a solid body, is collected by the ear, as the pulsations travel onward, and transmitted directly to the auditory nerve.*

Those beings only which are denominated locomotive, having the power of moving themselves from one place to another, have an ear. Without this sense, of such vast importance to man, inferior tribes would be constantly exposed to dangers and even destruction. Nature has not been neglectful in granting the necessary means of happiness to every being, in proportion to its wants in the sphere in which it is destined to live; nor partial to man, in the development of all his senses, to the exclusion of other animals, whose physical propensities, necessities and circumstances are of as much importance to them, in the scale of existence, as his own.

EXTERNAL EAR.†

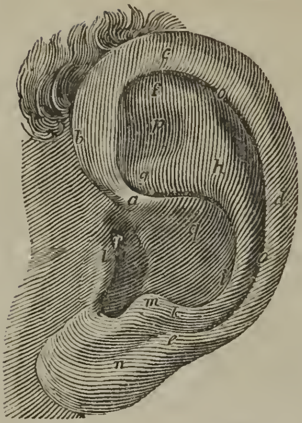
That appendage termed *auricula*, *pinna*, or external ear, divested of the skin, is a thin, delicate piece of cartilage, quite elastic, and bearing some resemblance, in this respect, to parchment. On its outer surface it is concave, but thrown into deep semicircular grooves, which terminate in one large dish, surrounding the canal that enters the bones, called *concha*, because it resembles a shell. The lines or eminences, lying between the furrows, have definite names, as helix, antihelix, tragus and antitragus, and, lastly, the fat pendulous portion, on the under edge of the ear,—in which trinkets are worn, in civilized society, in humble imitation of genuine savage life,—the *lobus*.

* The antennæ of insects are considered the only organs that convey a sensation analogous to hearing. By the vibrations communicated to the body through these, they are probably made susceptible of simple sonorous impressions.

† So called from *aura*, air.

What produces sound?
Name the central portion of the organ of hearing.
Do all animals possess the sense of hearing?
What is the auricle?
Where is the concha?

Fig. 70.



Explanations of Fig. 70.

This is a well marked ear of a man, drawn from life.

a to *e*, The *helix*, forming the rim.
a, The upper end or commencement of the rim, sloping into the concha.
b, Part of the edge lost in the face.
c, *d*, Prominent from the head.
e, The fold terminating in the lobule of the ear.
f to *m*, The antihelix.
f, *g*, The upper end divided into two ridges,—*h*, the union of them,—*f* and *g*.
i, *k*, Lower end of the *antihelix*, continued at *i* into the concha, and at *k* into the *antitragus*.
l, The tragus, covering the entrance to the ear, like a post at the corner of a street, to prevent sudden injury.
m, *Antitragus*.
n, *Lobe* of the ear, usually bored.
o, *o*, Furrow between the helix and antihelix.
p, The boat-like depression between the lines of the *antihelix*.
x, The *concha*.
r, The beginning of the *meatus auditorus*.

MUSCLES.

Although in the human species there are muscles which seem at first sight to have been designed for moving the ear in different directions, their office is expressly to keep it tense, equally on the stretch at all points, to increase its vibratory property. Occasionally, individuals are seen who have such development of the muscles as to be able to move their ears at pleasure. Wags and buffoons are sometimes expert in the exercise. There are three of these muscles.

All such animals as keep their ears habitually erect, as the fox, lynx, cat, horse, ox, ass, and various species of the dog, maintain them in that position by the strength of the muscles, which are under the control of the will.

It is necessary for safety on the one hand, or success in seizing prey, by surprise, on the other, for the animal to

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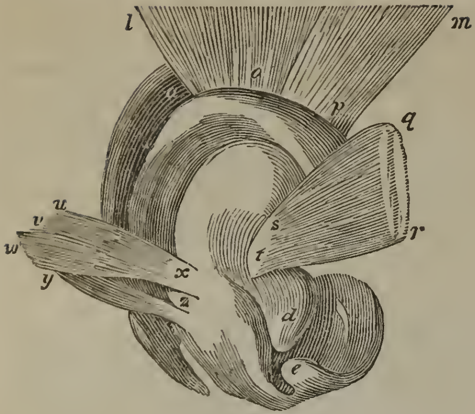
Has the external ear any muscles? Their use? If so, how many?

Fig. 71.



Explanations of Fig. 71.

In this plate is represented the muscles peculiar to the external ear. *a*, *d*, *e*, the cartilage of the ear, as seen on that side looking towards the head.

The attolens aurem, or lifter up of the ear, marked *l*, *m*, shows where it becomes tendinous on the bones of the head. *o*, *p*, attached to prominences.

g to *t*, the *anterior auris*, placed between the face and ear. *q*, *r*, the portion of it connected to the muscle of the forehead, growing narrower at *s*, and inserted into the *helix* at *t*.

u, *z*, Two muscles, or rather two portions of one, *retrahentes aurem*, to draw the ear back from the face.

u, *v*, *w*, *x*, The upper or larger portion, consisting of fleshy fibres, *u*, *v*, *w*.

y, *z*, The inferior portion of the same muscle.

have a distinct auricular perception, accompanied by a nice sense of smell. By remaining perfectly quiet, the ears are directed to and fro, as circumstances may require, to receive most favorably and forcibly the sonorous rays, without being obliged to move the head.* Elephants, hounds, besides an almost endless catalogue of mammalia, have pendulous ears, as though the design was to defend the orifice. In these examples, the muscles are small, as they are in man.

* An ear trumpet for deaf people, instead of being like the funnel of a common bugle, should have a broad plate, grooved, and, indeed, wrought in exact imitation of the external human ear. This is the best mode of directing sound into the head, or nature would have constructed it differently.

Birds have but a slight rim, approaching in outline the pinna: lizards, of which there are about forty varieties, serpents, and other reptiles, have nothing externally resembling an ear: in some it is difficult, on close examination, to discover the precise spot where the ear is located. Fishes are also destitute of an external organ; and yet all these families, including the amphibious, as frogs, turtles, and the like, have a beautifully constructed internal ear, as remarkable, so far as a mechanical arrangement of parts is concerned, in conveying the pulsation of sound, as that of the most favored musician.

EAR TUBE.*

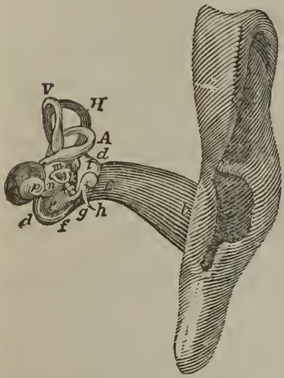
When the temporal or side bone of the head, containing, entirely, the internal ear, is carefully sawed in twain, the canal of which we are speaking will be found about three quarters of an inch in length, and somewhat contracted towards its inner extremity, and, on an average, a little less than a quarter of an inch in diameter. This passage is a gentle curve, as the tube, from the external opening, rises upward; but at half its length turns downward again, and there bulges out in shape something like the bowl of a spoon. A delicate rim, like a moulding, rises on the edge of this expanded mouth, for sustaining the drum-head, soon to be noticed, very much as a hoop is nailed within the mouth of a barrel, near the edge, to keep the head from falling in. To afford greater surface, that the drum-head may be considerably larger than the extremity of the tube would allow, were it stretched perpendicularly across, it is sloped, so that it requires an oval cover, under such circumstances, very much larger than if it were round, and fitted to the square end of the pipe. All this may be examined in the temporal bone of a horse, sheep or dog's skull, as they are found bleaching in the fields. In these animals the resemblance to the

* In books, termed the *meatus auditorius externus*,—simply meaning the external passage to the inner cavities.

How does the external ear of birds differ from those of some other animals?
Have reptiles ears?
In what bone is the auditory apparatus found?
Give a general description of the tube which admits sound into the interior.
Where is the drum of the ear?

human ear is particularly striking. The common skin of the face is carried within the tube, for its lining, but perforated in numerous places, by the ducts of delicate little bags, lying between the bone and skin, which are constantly secreting and pouring out a bitter, nauseous wax. The object of this excretion is twofold, viz. first, to keep the lining moist and pliable; and secondly, to kill insects that may intrude there.* Crossing this canal from the sides are ong, short hairs, intersecting each other in such a manner, that an insect must overcome the resistance of those pikes, or chevaux-de-frise, in case

Fig. 72.



Explanations of Fig. 72.

This has been an exceedingly difficult plan to execute, so as to give the exact relation of parts; hence it is very much foreshortened.

c to *d*,—*cc*, the *meatus externus*, as it appears, taken from the bone; *b*, *c*, its two curvatures;—the first *e*; the second *c*:—*dd*, the oblique slant, like a spoon bowl, at the inner end, covered by the *drum-head*, spoken of in the text.

e, The *membrana tympani*, stretched on its bony hoop, bulging inward.

The remaining parts, beyond the boundary of the membrane, remain to be described, although represented here for the sake of keeping up the connexion of parts in the mind.

f, *g*, *h*, The *malleus*; *f*, its handle; *g*, its long *handle*; *h*, the head or bulb.

i, *k*, incus, or anvil; *i*, short, and *k*, long processes; *m*, *stapes*.

V, H, A, *m*, *n*, *p*, The labyrinth; *n*, *p*, the cochlea; *n*, the beginning, *p*, termination; *m*, the vestibulum.†

* Ear wax is certain death to insects that feed upon it; though its composition is such that they cannot restrain their appetites when pent up where it is. Naturalists have taken a hint from this, to prevent the depredations of vermin on dried preparations in cabinets, by washing them in decoctions of aloes or other vegetable bitters.

† I have found considerable difficulty in demonstrating this organ, without very large models: one now in my cabinet, made of wood, magnifies the internal ear three feet, which can be seen and understood at a distance in a large hall. Formerly, when I taught anatomy in a Medical Institution, it was customary to suppose the college an ear, and thus illustrate its intricacies by constant reference to the apartments and

How is the tube lined?
Of what utility are the hairs growing within the tube?

the wax * does not arrest its progress, before reaching the drum-head, where its peregrinations are impassably limited.†

THE DRUM, OR MEMBRANA TYMPANI.‡

From the foregoing description of the canal, the exact locality of the drum-head will be understood. Fitted to the rim of bone, in a manner similar to the parchment over the barrel of a snare drum, it is kept perfectly tense, but by an arrangement of the fibres peculiar to its organization. It is oval, and somewhat concave outwardly, and so transparent that objects can be seen through it, being of the color of white oiled paper. Any person of common ingenuity can dissect this beautiful membrane in the head of a dead fowl, with the point of a knife. It then presents a striking resemblance to a battledoor. This closes up the extremity of the tube, in a healthy ear; notwithstanding, it is frequently ruptured by the firing of heavy guns, inflammation, and other accidents, without producing deafness. Across this drum a fine thread of a nerve is drawn, called corda tympani, which gives it the requisite sensibility and connexion with the system. When a pin-head is introduced far enough to touch the drum-head, an exquisitely acute pain is the consequence, from pressing this nerve.

passage ways of that edifice. Instructers will derive great advantage from a similar course; by considering the schoolhouse, when explaining the organ to their pupils, the internal ear, and the front door the drum.

* At birth the tube is filled with a thick mucus, which, in some children, unless speedily removed, forms a cake of hard wax, completely closing it; and by the time the articulative organs are developed, the child is actually deaf and dumb. There seems to be a peculiar predisposition to this in some families. In others, children, after having once talked, lose their hearing at four or five years of age, and become permanently deaf and dumb.

† When the glands are diseased in consequence of a chronic inflammation, a thin, purulent discharge takes place, giving the individual, in some instances, trouble, inconvenience, and pain through life. I have seen a skull, in which the entire tube on one side was closed up by a deposition of bone. The opposite ear was partially diseased in the same manner, but the peculiar circumstances of the case, while the person was alive, could not be ascertained.

‡ Lobsters, crabs, and, in fact, all that remarkable class of animals whose skeletons are outside of the body, in the form of a shell, have their ears placed at the extremities of projecting points. The lobster's can be detected at the end of a short stump, near the root of the long feelers; it consists of a perforated bony stump, having a membrane stretched over it, covering a drop of fluid, in which floats the auditory nerve.

We have seen men with the membranes ruptured on both sides, which was inferred from the fact, that in smoking, they puffed the fumes, for amusement, out at their ears; yet the sense of hearing did not appear impaired. This will be subsequently explained. The deafness of old people might in some instances be alleviated by puncturing the membrane, which, by age, has become thickened and inelastic.

No one can be in doubt as respects the office of this membrane: it receives the sonorous rays, having a broad surface, and being on the stretch, is put in vibratory motion by the slightest pulsations in the air, which it transmits to the still more important apparatus within.

We have remarked that reptiles and fishes have no discernible external orifice: the external surface appears smooth, as though they were destitute of this sense. Under the skin, however, and in the bone answering to the temporal one in man, there is a round hole, growing larger within. This cavity is the *tympanum* or drum-barrel, answering to the apartment beyond the drum-head in men and quadrupeds. The common skin which is thus drawn over the mouth of the tympanum, acts precisely as the drum-head does,—vibrating to the least noise, with exceeding nicety. In the economy of reptiles, those scavengers of the earth, created to wallow in filth, at the threshold of organic life, an external opening would be soon destroyed, by being filled with mud, gravel, or insects. The skin over the frog's ear and the chameleon is very dense, shining, and tremulous. Frogs, particularly, have a splendid circular piece of skin over the tympanum, just back of their large, prominent eyes. There is a necessity for uncommon delicacy in their case, as their ear is constructed for hearing with equal precision in water as well as air.*

* In that class of serpents which are covered with scales, the external contrivance of a tense skin over the internal ear is far inferior to the frog or lizard's: to the under side of a cluster of thin scales, wedged in the loose skin, a slender bone, in figure like the pestle of a mortar, runs into the tube, towards the brain, and plays into the fenestra ovalis.

All the variety of serpents are distinguished for their delicacy in the perception of sound. The *boa* family, particularly, are those which exhibit the most satisfaction in music. The writer has carefully exa-

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Can the membrane be ruptured without detriment to the organ? How could the deafness of aged people sometimes be remedied? How is this membrane arranged in reptiles?

INTERNAL EAR.

All parts beyond the drum-head are collectively called the *labyrinth*, in consequence, probably, of their intricacy.

To understand the arrangement of the apartments to which the reader is now to be introduced, requires patience, as well as close observation, or the mechanism cannot be comprehended. First, the

DRUM-BARREL OR TYMPANUM.

Directly behind the membrane is a small room, of the capacity of a common white bean. Its name is derived from a word meaning a drum, as it is one in office, but having, instead of one head, like the kettle, or two, as in the snare drum, it has three heads; the largest of which is towards the outer ear, while at the other end of the barrel are two little ones.

Three distinct apartments, one beyond the other, which in anatomical works have further minute subdivisions, collectively make up the labyrinth. First, the *tympanum*, just adverted to; secondly, the *vestibule;* and, thirdly, the *cochlea*. In connexion with these are certain tubes, having sundry barbarous, unintelligible names.

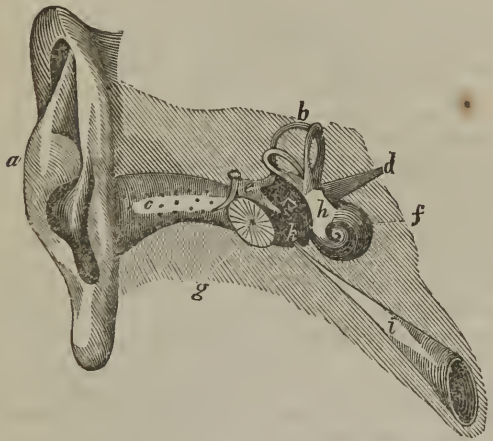
Behind the ear, a hard knob of bone may be felt, with the finger, (mastoid process,) on which that muscle is fastened, which, with its fellow on the opposite side, brings the head forward; within, it is hollow, being full of conical cells resembling the spokes of a wheel, growing smaller as they unite in one pipe, which opens into the drum-barrel. Physiologists agree that the use of these cells is for reverberating sound, that it may gain strength by being reflected from wall to wall, in order to excite a stronger sensation when conveyed to the nerve: these

mined a *boa constrictor*, which, when fully grown, is horrible to the sight, that was inattentive to sounds, except when hungry. At such times, the scratch of a pin against the wall roused the monster to unceasing watchfulness. The ears of the land tortoise and the rattlesnake do not differ as much as the physiologist might at first suppose, though in the water turtle, constituted for hearing alternately in air and water, there is a perceptible difference. In the first a single bone is found; while in the latter, in addition to the bone, there are fine chalky particles, which move against each other, to propagate the motion or noise in the water to the ramifications of the nerve.

Where is the labyrinth?
Describe the tympanum.
Vestibule.
Of what service is the mastoid process?

are particularly large in some animals.* A similar piece of mechanism is discoverable in the cheek bones, and even the centre bone of the skull, for reverberating and strengthening the voice. Lions have large cavities in the bones of their heads and faces, on purpose to increase the intensity of the vibrations; hence their characteristic roar.

Fig. 73.



Explanation of Fig. 73.

One principal object of inserting this figure, was for the purpose of showing the relation which the *Eustachian tube* bears to the tympanum. It will be recollected that this tunnel-shaped canal opens in the back part of the mouth.

a, the external ear; *b*, *the semicircular canals;* *c*, the meatus, or tube from the extreme concha to the tympanum; *d*, spicula of bone, not essential to remember; *e*, *the incus;* *f*, the cochlea; *g*, the drum of the ear; *h*, the vestibule; *i*, the *Eustachian tube;* *k*, the tympanum, in which the little bones are placed. The Eustachian tube terminates, and the oval window opens into the vestibule.

* In a letter from the venerable Dr. James Thatcher, of Plymouth, the following curious fact is related:

"A gentleman told me that a few days since, as he was passing through one of our streets, where there were considerable intervals between the houses, a gentleman, totally blind, walking with him, assured him that he knew exactly when he was passing a building, by a peculiar sensation in his ears, occasioned by a different concussion of the air."

Why are the cavities large in the lion?

In another direction is the minute orifice of a cone-shaped pipe, *Eustachian tube*, that opens with a trumpet-like extremity in the mouth,—it being necessary to the free vibration of the drum-head that the same quality of air that transmits the sonorous pulsations should also exist on the opposite side, within the barrel: the use of the *Eustachian tube*, (so called from Eustachius, the discoverer,) is to admit it. Nothing, therefore, is more completely an imitation of the tympanum of the ear than the martial drum, which has a little hole in the side, equivalent to this we are describing, descending to the mouth, the nearest point from which atmospheric air could be taken, without disarranging or disturbing the functions of other organs. By closing the sounding hole of the drum, the music is less audible,—sounding, when the air inside becomes rarified, like music in a well. The reason is, the equal balance of the air is destroyed: such is the object and office of the Eustachian tube. Sometimes, in violent sneezing, or sudden cough, the patulous mouth gets stopped for an instant with saliva; and many readers are probably familiar with the sensation of fulness that ensues, —giddiness and ringing in the ears, to the annihilation of accurate auricular perceptions, till the cause is removed.*

There are many existing cases of deafness having their origin in some such cause: the pipe finally inflames, and becomes permanently sealed. A skilful aurist, under such circumstances, will adroitly puncture the drum-head, with an instrument purposely constructed, and relieve the patient without pain.

OVAL WINDOW, OR FENESTRA OVALIS.

Fenestra ovalis means an oval window, covered by one of the two little drum-heads. Beyond this, supposing a person could pass through, he would arrive in the vesti-

* Notwithstanding the fine arguments of writers to the contrary, I believe that partially deaf persons hear better when the mouth is open; instinctively, it may be observed, such individuals listen with an open mouth. The pulsations of sound thus enter the tympanum and set the fenestra ovalis vibrating, but very much less forcibly than through the external opening in its healthful condition.

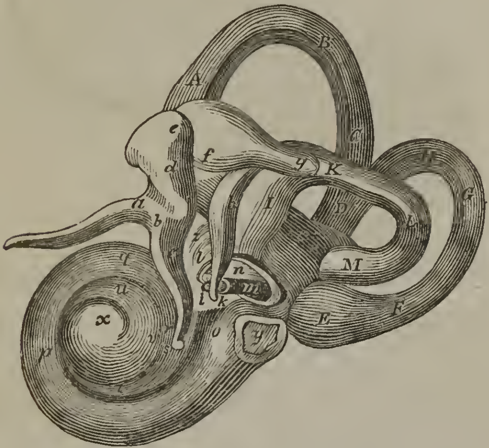
Use of the Eustachian tube?
Does it communicate with the mouth?
For what purpose?
Common cause of deafness?
Where is the fenestra ovalis?

bule, or second room. Lower down, but a few lines from this, is the second little parchment head, called

ROUND WINDOW, OR FENESTRA ROTUNDA.

This is a round window; were it possible to tear it away and creep through the frame, the traveller would enter into one of the canals of the cochlea.

Fig. 74.



Explanation of Fig. 74.

In this diagram, the labyrinth and little bones of the ear are magnified exceedingly. This is to show the manner in which they are connected, and the order in which they are placed.

a to *e*, The *malleus*, about to be described; *a*, a long process; *b*, a shorter one; *c*, the handle, attached to the drum-head; *d*, the neck; and *e*, the head of the malleus, like a mallet.

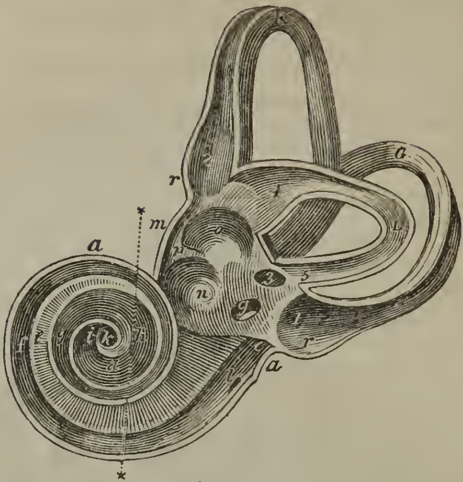
f to *i*, The *incus; f*, its body; *g*, its short leg; *i*, the point united to the *stapes*.

k to *n*, The stapes; *k*, its small head, *i*, the anterior leg, *n*, the basis connected with the membrane which closes the fenestra ovalis.

o to *m*, The labyrinth; *o*, *r*, the first turn of the *cochlea; s*, *t*, *u*, *v*, the second; *w*, *x*, the half or third turn; *y*, the *foramen rotundum* or round window; *z*, *z*, the vestibulum; A B C D, *superior semicircular* canals; A, the *ampulla;* B C, its curvature; D, its union with the inferior or posterior canal; E F G H, inferior canal; E, its ampulla; F G H, its curious curve and its junction with the first; I K L M, the exterior canal; I, the ampulla; K L, the direction of its curve; M, its termination in the vestibule.

Is there a round opening?

Fig. 75.



Explanation of Fig. 75.

In this, the bony case of the labyrinth has had one half cut away to exhibit the interior.

a to *l*, The upper part of the cochlea; *a a*, the thickness of its external shell in a fœtus of eight months; *b*, *c*, *d*, the lamina spiralis; *b*, *c*, scala vestibuli; *e*, *f*, *g*, *h*, *i*, the scala tympani. Here is seen the bony lamina spiralis; *b*, its origin; *d*, its termination in a little hook, termed *hamulus*; *k*, the opening of the infundibulum, where the scalæ communicate; *l*, the opening of the aqueduct, or drain of the fluids from the cochlea.

m to *g*, The under half of the vestibulum; *m*, the thickness of its case in the fœtus; *n*, the fovea or round pit; *o*, an oval pit; *p*, a ridge between them; *q*, opening of the aquæductus vestibuli.

r, *g*, *k*, *l*, The canals divided; *r*, the thickness of their case in the infant; *g*, the posterior; *l*, exterior semicircular canal; 1, opening of the big end of the posterior canal; 2, opening of the large end of the superior; 3, the opening common to their united tubes; 4, the larger end; 5, the contracted opening of the external canal.

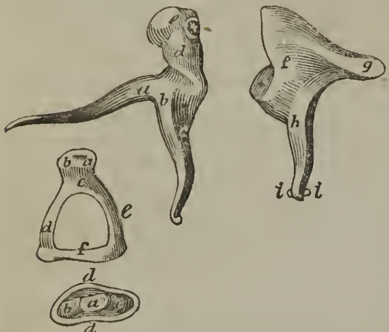
LITTLE BONES OF THE EAR, OR OSSICULA AUDITUS.

Perhaps there is no insulated portion of an animal that more clearly and satisfactorily evinces superhuman design, than the figure and articulation of the four ear bones, which we shall now endeavor to describe. The technical phrase *ossicula auditus*, in the Latin, implies *little bones*

How many bones concerned in the sense of hearing?

of hearing. They are by far the smallest in the body. The first, in the order of their distribution, is the *malleus* or mallet, having a faint resemblance to that instrument, inasmuch as there is a long handle joined to a round knob. Secondly, the *incus*, from its resemblance to an anvil: *os orbiculare* or round bone, the least in size that has ever been discovered, benig in man considerably smaller than a mustard-seed. And, lastly, the *stapes*, or stirrup, almost a miniature fac simile of a saddle stirrup. Birds have but two of these, of which the malleus is most developed. Turtles have but one, the malleus; and reptiles, as far as personal dissection warrants, have but two. In these classes there is a departure in form from those we are contemplating in our own species.

Fig. 76



Explanation of Fig. 76.

Here is presented a magnified view of the ear bones. The *os orbiculare*, or round bone, is not represented, being considered by some as only an appendage of the malleus.

The *malleus* known by its long arms; *a*, *b*, *c*, *d*, *e*, mark the same points as in Fig. 74. The *incus*, resembling a molar tooth, having shorter arms, is in the same position as in Figure 74; the letters have the same reference. The *star* points out the articulating surface for the malleus.

Any person, from the foregoing remarks, will recognise the stapes, by its shape. *a b*, its head; *c*, the neck; *d*, anterior *crus*; *e*, the second; *f*, the basis.

The fourth drawing represents another view of the stapes, seen from above. *a*, its cartilage; *b*, anterior; *c*, posterior; *d*, the basis.

As these bones are placed in the drum-barrel, one joined to the extremity of the other, they make a compound lever, the object of which is to have the freest and longest extent of motion in a little space. Unlike the military drum, which is continually referred to on account of familiar illustration, the sticks of this are fixed on the inside, connected to little cords, which jerk them down

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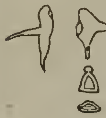
Give their names.

with a sort of conscious independence, whenever there is the least noise, to give the brain intelligence, as it were, of what is going on without.*

Fig. 77.



Explanation of Fig. 77.

In this drawing the little bones are represented of their natural size, with the exception of the last one, which is magnified.

There is some resemblance in the motion to be effected by this chain of bones to the up and down motion of the hand at the extremity of the arm, viz. carrying one end of the lever through considerable space, while the other, to which the power is applied, has no perceptible motion.

Small as the ossicula auditus are, the first and last of the series have muscles, called *tensors*, *laxators*, &c., which are susceptible of demonstration. Rough points and projections on the inside of the tympanum give attachment both to the muscles and the bones themselves. Even these minute points the old anatomists have belabored with what they supposed significant names. One end of the malleus, the handle, is connected with the inside of the membrana tympani; the other is fitted into a socket of the incus, and that articulated with the or-

* There are some diseases familiar to medical gentlemen, beside local affections of the ear, which fix upon the bones about the face. Under such circumstances, a sanious discharge washes these little bones entirely away. Nothing is more certain than the fact, that the three first bones may be corroded and floated from their connexions: indeed, extracted with forceps, and the patient hear, to all intents and purposes, nearly if not quite as well as he did before. Thus the membrane, (drum-head) and three out of four bones are unnecessary, it seems, in the auditory apparatus of man. Stripped thus, it falls below the frog's, being deficient in an external covering or vibrating membrane. The vibrations, in this case, act directly on the foot piece of the stapes, which is broad enough to offer resistance to the vibrating air. Being connected with the membrane of the *fenestra ovalis*, it produces a motion in it, which is propagated to the fluid beyond, and thus the nerve becomes agitated. If the stapes could be detached without rupturing the membrane of the fenestra ovalis, then hearing could be effected independent of the little bones. Their use is merely to strengthen the vibrations within, just in the proportion that they have a tendency to become faint as the distance increases whence they had their origin.

Upon what principle do they act within the tympanum?

Have these little bones any muscles attached to them?

biculare or round bone, which stands as a medium of connexion between the two.

Such is the mechanical adaptation of one of these bones to the other, that if the extreme point of the handle of the malleus be moved the millionth or ten millionth part of an inch, by the vibrations of the drum-head, it will so operate on the incus and that on the stapes, through the intervention of the orbiculare, that the last bone will move through treble the space, by a single sonorous pulsation of the malleus, in the same period of time. In fact, the stirrup, in plain language, is exactly fitted into the oval window, like the box of a pump, so that a motion given to the handle of the malleus operates on the chain, to effect the stapes, that it may work backward and forward, with the same motion and on the same principle of the working of the piston of a syringe. *To hear*, it is necessary that the stapes, attached to the parchment window, should move to and fro.

ENTRY, OR VESTIBULE.

This word implies an entry, being an intermediate apartment between the tympanum and cochlea. In the sense in which it is now received, it is a *hall* of the edifice beyond, from which doors are opening into various winding passages. Its length and diameter are not far from those of a grain of wheat; as in a preceding paragraph, if we suppose an individual has torn away the stapes, stretched across the oval window, and then cut away the latter, to wend his way into the vestibule, he will find it a long but narrow room.*

On one side he will discover three holes, and on the opposite only two, which are the openings or communication of the semicircular canals with the vestibule.

* If, by any circumstance, the membrane of the *oval window* or *fenestra ovalis* is ruptured, the fluid of the labyrinth will certainly escape. This constitutes incurable deafness. No operation, no prescription can avail, as the acoustic nerve cannot be acted upon in any other way than through the agitation of the fluid which surrounds it. Dr. Darwin was of opinion that if a deaf person dreamed of hearing, the internal parts, essential to the function, were unimpaired. The same remark is applicable to the blind. I have invariably found that the incurably deaf, as well as incurably blind, never dream of hearing or seeing. This clearly shows a destruction of the sense, inasmuch as the imagination cannot rouse a single vestige of their former activity.

Where is the vestibule, in relation to the other cavities?

How many cochlear orifices within the vestibule?

Within this vestibule are two sacs, water tight, containing a clear fluid. Though there is no communication between them, the quality of the fluids distending them is alike. One is considerably larger than the other, and both together would not equal in bulk two good sized pin-heads. The one of the greatest magnitude is called the *alveus communis*, or the union of rivers, from the circumstance that the canals were thought to resemble streams of water, having a free communication with the water in the reservoir. *Sacculus cochlea*, the lesser one, though separated from the other by the thickness of its own and the other's wall, is eked out into a long gyrating tube, that traverses the cochlea.

This large sac, *alveus communis*, is the elementary one found in polypi; and it is this that is built upon from one species to another, till perfected in the complicated machinery of the human ear.

Besides the sacs themselves, the porch is lined with a membrane of exquisite texture, in which is conducted the vessels that administer the blood to the contained reservoirs, and also secrete their contained fluid, *aqua labyrinthi*, or water of the labyrinth.

SEMICIRCULAR CANALS.

These are properly a prolongation of the vestibule; the design evidently being to furnish surface for expanding the auditory nerve, without carrying it onward towards organs that would be affected by their presence. No way could be devised more strictly economical than to have a circular or semicircular canal, curving in a little space, as in a very small solid bit of bone. Precisely on this plan are these canals. They are three in number. Let it be remembered in this place that the tympanum, including the vestibule, little bones and semicircular canals, exclusively make up the ear of fishes and reptiles; neither of these tribes having an external ear, nor the cochlea, which still remains to be elucidated.

So much is necessary to the perception of simple sounds. The cartilaginous fishes (sharks, eels, &c.) have the canals, and are therefore capable of judging of the

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Are there sacs of fluid in this apartment?
How many semicircular canals?
Have other animals the same organization in this respect?

direction and condition of different sounds.* The Chinese drive fish from the crevices of rocks to the angling ground by beating a gong. Pike and carp, reared in artificially stocked ponds, both in Poland and France, have been taught to come to a particular spot to feed, at the ringing of a bell. Serpents, abundant evidence substantiates, are exceedingly excited by the lively strains of music, coiling themselves into a variety of folds, and giving a tremulous vibration to the tail, which long experience proves to be the result of a pleasurable sensation, and not one of displeasure, rage or pain.

Two of these canals, as they wind towards the side of the vestibule, coalesce; and when they perforate the wall, have only one orifice in common. The third enters alone, and this explains the two holes seen on one side of the vestibule; on the opposite side are three, being the orifices of the same three canals, opening singly. When the semicircular canals are closely examined, they are observed to be larger at one extremity, near the walls of the vestibule, than at the other; the bulbs or bulges are termed *ampullulæ*, or bottle-shaped. A crook-neck squash is an exact, though greatly magnified representation of any one of the semicircular canals. The diameter of the

* Spinous fishes, those possessing firm cranial bones, have no external opening—*meatus externus*.

A singular malformation in relation to the ear has been discovered recently, in a young man in Vermont, a printer. There are no orifices from the external leading to the internal organ. Yet he hears tolerably well. Various theories have been advanced in explanation of this phenomenon. Some have suggested that the portio dura, which accompanies the acoustic nerve, and branches about on the side of the face, transmits the sonorous vibrations of the air. One thing is certain, viz. that, although the external part of the auditory apparatus is imperfect, the labyrinth is perfectly developed. Were it not so, he would not hear. It is most philosophical to suppose that sounds or aerial undulations are propagated and communicated to the auditory nerve by the concussion which the whole skull receives. Fishes, as noticed in the text, hear distinctly, without any external opening. Sound to them is the effect of a tremor produced in the bones of the cranium, extending to the acoustic region, which agitates the nerve. If this is not the case with this printer, then we must suppose the tympanum exists, and that sound is introduced there through the Eustachian tube, a canal extending from the back part of the mouth. So seldom is it that any of the organs of sense are malformed, that this is considered an extraordinary instance.

A native of the Sandwich Islands was seen by an American gentleman, who had *four* external ears, two on each side, one being just above the other. Whether there were four orifices, he did not ascertain.

What is the appearance of the extremities of the canals?

What diameter have they?

circle, of which they are a little more than two thirds of a segment, varies but little from one quarter of an inch in man: but the calibre of the canals themselves will scarcely admit the introduction of a fine bristle. A probable reason for the swelling out of the ampullulæ will be given when discoursing particularly of the nerve.

Fig. 78.

Explanation of Fig. 78.

In this enlarged diagram of the labyrinth, which is laid open, the soft parts are seen. Young gentlemen pursuing medical studies will derive the most profit from this plan.

a to *e*, The *lamina spiralis* viewed from above. The distribution of the nerve will not be easily distinguished, I fear; *a*, *a*, *a*, the first turn; *b*, *b*, second turn; *c*, *d*, *e*, the third turn of the lamina; *d*, *e*, where the scalæ communicate.

Comparetti has described the lamina to consist of four different substances, or zones; 1, the bony zone; 2, coriaceous; 3, vesicula; 4, the membranous zone.

f, *sacculus sphericus;* *g*, space between that and the *alveus communis;* *h*, *alveus communis;* 1 *k* *i* 3, posterior canal; 1 *i*, its ampulla; *k*, the nerve expanded over it; 2 *l* *m*, the superior canal; *l*, the ampullulæ; 4 *n* 5, the exterior canal, communicating at both ends with the *alveus communis*.

Within these bony tubes are membranous ones, prolongations of the sacs found in the vestibule; but they are not in contact with the walls: on the contrary, they are kept from them by the interposition of a fluid, whose equal pressure keeps them exactly in the centre. Fur-

ther to show the exceedingly minute structure of this accurately operating instrument, it is necessary to remember that the membranous tube is also distended with a transparent watery liquor. Still smaller canals, running through the temporal bone in which the internal ear is located, pour in and discharge the old fluid, as an unceasing process.

SNAIL-SHELL, OR COCHLEA.

The third and last anatomical division of the internal ear is the *cochlea*, or snail-shell. Recollecting how the canal of a snail-shell winds about a central pillar, will enable the reader to understand the text. In the snail-shell of the ear, however, there are two canals, side by side, which wind twice and a half round a central pillar, which is hollow, and termed *modiolus*. At the apex, the two canals open in one common cavity, but a thin slip of bone caps over both openings, as well as over the top of the hollow end of the pillar, like a parasol. This is the *cupola*, in technical language. The upper end of the hollow pillar is broad, but becoming narrower, the lower is denominated the *infundibulum*, or tunnel-shaped extremity.

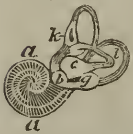
After leaving the inner extremity of the vestibule, commences one canal of the cochlea, which becomes smaller and smaller, till it terminates under the *cupola*. Now, supposing the reader were travelling in this canal, he could step from the termination of the one we are describing, over the broad opening of the *modiolus*, shaded above by the cupola, into the mouth of the second canal. By following its turns, increasing in diameter as he proceeds, till he has gone twice and a half round the modiolus, he would arrive at the *fenestra rotunda*, or round window. This being like parchment, semi-transparent, he could look into the *tympanum*, where the little bones are lodged.

Thus it is that one canal is in reality a prolongation of the vestibule, and the other opens into the tympanum. A fluid fills the canals, which is prevented from escaping by the oval window, in the vestibule, in one direction, and by the round one at the other. In the centre of this liquor, floating, are the finely organized threads of the acoustic nerve.

Where is the cochlea?
What are the peculiarities of its structure?

Those animals having the power of combining sounds to produce song, have a cochlea, and generally a corresponding vocal apparatus. Birds have a cochlea, but it consists only of two tapering tubes, united at one extremity, but diverging at the other, as in man. A musical ear was once thought to depend exclusively on a cochlea; but common sense teaches us, and the fact is notorious, that singers, as well as those who cannot sing, have ears constructed precisely alike; and therefore the whole mystery depends on the peculiar development of the brain.

Fig. 79.



Explanations of Fig. 79.

Part of the last, as well as the following diagram, which has a sort of shell-like turn, is denominated the cochlea.

The object of this drawing is to show the soft contents of the labyrinth, of their natural size and in their natural situation. All the eminences of the temporal bone have been broken away.

a, *a*, the spiral plate of the *cochlea;* *b*, the round sac, or sac of the cochlea; *c*, alveus communis; *g*, the posterior; *k*, the superior, and *l*, the exterior semicircular canal.

THE HEARING OR AUDITORY NERVE.

There is no part of the intricate organ we have been explaining more difficult to display and to fully understand, in all its relations, than the nerve of hearing; and we shall therefore avoid all laborious descriptions, and merely generalize.

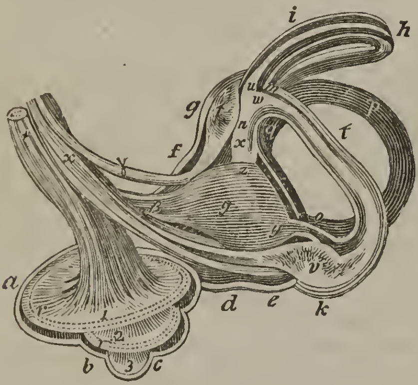
The auditory nerve is the seventh,—a pair precisely alike on the two sides of the brain; not much larger than sewing threads. It enters the cochlea first through a sieve-like orifice, on one side of a bone that projects from the inside of the skull towards the brain. This depression where the nerve enters, towards the external ear, is the *meatus auditorius internus.* It assumes a variety of shapes in distributing itself in the various tubes, sacs, canals and pits we have been exhibiting. At some points, many delicate threads are discoverable, side by side; at others, fibres are seen floating in the surrounding fluid. from the main trunk; at others, the nerve assumes the form of a flocculent paste, and at others, a woolly texture.

How is it constructed in birds? Is there a fluid in the canals? Describe the auditory nerve.

The whole, distributed thus elaborately, constitutes the nerve of hearing.

The sense of hearing is not confined, in a healthful condition of the organ, to any one particular part or point: the sensation is perceived in the whole at the same instant of time. It has been recently demonstrated that the human ear is so extremely sensible, as to be capable of appreciating sounds which arise from about

Fig. 80.



Explanations of Fig. 80.

An enlarged view of the labyrinth laid open.

a, *b*, *c*, the *cochlea*. To exhibit the zona mollis, the outside or bony case is removed.

d, *e*, *f*, The vestibulum.

g to *q*, The semicircular canals.

g, *h*, *i*, The posterior; *k*, *l*, *m*, the superior; *o*, *p*, *q*, the exterior canal.

1, 2, 3, The lamina spiralis, seen on its under surface; 3, the two sacs so often mentioned in this work, in the vestibule, which, viewed in this plan, look like one.

t, *u*, The membranous posterior canal.

v, *w*, *x*, The superior membranous canal, uniting with the last, at *x*, *y*, *z*, the exterior membranous canal.

This diagram exhibits the distribution of the *acoustic nerve* in the labyrinth; the large branch goes to the cochlea, and the three others, smaller, to the vestibule, and three semicircular canals.

24,000 vibrations in a second; and, consequently, that it can hear a sound which lasts only the 24,000th part of a second. The question now may arise, why was it neces-

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In what division of the internal ear is the sense of sound developed?

sary to construct such an intricate machine, if one part of it has not a higher office to sustain than another?

Economy was the object:—to pack as much as possible in the smallest space, is observable in all animal mechanism. No other kind of arrangement of cells in the small block of bone in which these are found, would or could have afforded so much surface to spread out such an extent of nerve. This is the probable reason for semicircular canals, the cochlea and their appendages.

MUSICAL EAR.

No question oftener arises, on surveying the auditory apparatus, than this, viz.—why has one person an ear for music, when another, whose internal organ is as beautifully and nicely constructed, is totally unable to appreciate harmonious sounds? The difficulty, probably, is in the peculiar development of some portion of the brain, and therefore does not arise in consequence of a defect in the original conformation of the ear. It obviously requires as delicate auricular perception to appreciate and imitate articulate sounds, as it does to sing in concert. It is by no means uncommon for an individual to cultivate the highest departments of instrumental music, and at the same time be wholly unable to sing. This is entirely owing to some defect of the vocal organs. A perfect organization of both, in the same individual, united to that inscrutable condition of the brain which gives the taste for music, constitutes the most gifted performer, and such as Handel, Mozart, Beethoven, Mad. Catalani, Garcia, the wonderful Paganini, and a few others, have exhibited to the highest degree of human perfection.

Another circumstance in relation to the musical ear, is the following: some persons have the ear as well as the taste for music, and yet find it impossible to accompany others in a performance. This arises, probably, in most cases, in consequence of a non-agreement in the tension of the drum-heads of the two ears, or a want of correspondence in the calibre of the internal tubes; hence one ear perceives sounds to be half a tone above or below the other. The same occurs in respect to the focal distance,

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How is the musical ear different from the non-musical?

oftentimes, of the eyes. Time rarely corrects the former, though in the latter it finally modifies the aberration.*

DISEASES OF THE EAR.

A ringing in the ear is an indication of a diseased state of the nerve; generally it arises from some slight inflammation. The beating of adjacent arteries, in consequence of inflammation in the throat, may excite the nerve, which being incapable of transmitting any sensation but that of sound, the *ringing* is an imperfect sensation. The eye, when the optic nerve is encroached upon by inflammation of surrounding parts, or the pressure of a growing tumor, transmits the sensation of light, though the individual may be in total darkness. Affections of the brain itself may remotely excite a morbid action in many or all the nerves of sense. Hence, persons dying of acute inflammatory diseases, complain of hearing loud and strange noises, although the apartment is perfectly still.

EAR-ACHE.

Very many individuals are subject to excruciating pain in the internal ear, on taking the slightest cold, or from exposing themselves to a humid atmosphere; and others seem to inherit the disease, which no application can remove. A peculiar irritability of the nerve that crosses the drum-head (*corda tympani*) may be one cause; the vascular covering of which, suffering from a chronic inflammation, compresses the nerve, and thus produces almost intolerable agony. Defending the external opening with cotton wool, or lint, is a common and rational defence; but the introduction of oils, spirits and the like, is often attended with pernicious consequences. Generally such cases end in deafness. Nature, to save the rest of the machine from becoming disordered, by its sympathy with a diseased member, finally destroys it, as firemen demolish contiguous buildings, to save a town,

* Philosophers of antiquity were more conversant with the doctrine of sounds than the moderns. The remarkable cavern, hewn in a solid rock by a celebrated tyrant, and called *Dionysius' ear*, is said to have been an exact model of the windings of the human ear. Vitruvius gives an interesting account of the manner in which the Greeks contrived to augment the compass of the voice in theatres, by placing large metal vases in different parts of those edifices.

when they can no longer master a threatening conflagration.*

PARTIAL DEAFNESS, FROM A COLD.

Probably, in a majority of cases, partial deafness arises from a slight inflammation of the tube opening behind the palate. In consequence of this, the balance between the air in the tympanum and mouth is destroyed, and the regular vibratory function of the membrane is altered. A deafness in one ear generally depends on this cause. Deafness in fevers is an excellent symptom, and offers encouragement in the worst cases, because it is an evidence of a diminution of the morbid condition of the brain.

PERMANENT DEAFNESS.

A total deafness implies a destruction of the organ: but we apprehend there are only a very few persons in this condition. Even in those unfortunate fellow-beings who are *deaf and dumb*, the faculty of hearing, to a certain extent, still exists. They hear the report of a cannon, or heavy thunder, which act so powerfully on the body as to rouse the sleeping energies of the nerve. In fact, the tremor is communicated through the bones of the head. Fishes of the bony kind have the organ of hearing acted upon in the same manner, as the nerve is completely cased up in solid bone, without either drum-head or external openings.

* Painful affections of the ear may be induced from habitually picking the ears,—a very pernicious practice. In India, where a class of men follow the profession of cleansing ears, cutting the nails, &c., though in that climate the secretions may be fluid, in greater abundance, and discharge freely, the plucking of the hairs and frequent introduction of *scraping* instruments render the organ irritable, and less accurate in the perception of sounds.

Tumors, ulcerations and other troublesome complaints are brought on by picking them. A sudden pressure on the *corda tympani*, a nerve belonging to the face, which crosses the drum-head, by the head of a pin, may forever after render it liable to inflame on the slightest exposure.

Fluids ought not to be poured into the external ear to *drown* insects as the worst consequences may ensue.

How is temporary deafness produced?
What causes permanent deafness?
Do deaf persons hear better with their mouths open?
Is the sense imperfect, after the destruction of the external ear?
Use of the ear-wax?
What operations are successful in re-establishing the sense of hearing?

CONCLUSION.

None of the organs of sense are more complicated or splendidly constructed than the one under consideration. The will has it but slightly under its control, and being unable "*to withdraw itself from impressions*," it has the curious apparatus of little bones to increase or diminish the intensity of impressions, like a regulator between the external agent and the nervous cords. Judgment, by the combined assistance of the other senses, perfects the function of the organ; and ideas without number are constantly ushered into being by the sense of hearing.

By this sense, music is a never-failing source of pleasure, heightened and infinitely modified, according to the physical development of the ear, and the discipline and education to which it has in modern times been subjected. The causes of the pleasure resulting from harmony and melody are very far from being satisfactorily explained, notwithstanding the sagacious conjectures and repeated attempts of the most able metaphysicians, as well as physiologists: we know no more of them than we do of the causes of the pleasures and pains of all the other senses.

THE EYE.

No one has been able to explain *how* or *why* we see. The visual organs are constructed with such exact reference to the laws of light, that telescopes and microscopes are but imitations and modifications of the apparatus of the human eye. There is a difference, however, between the animate and inanimate, the most wonderful and astonishing. The first is a *perceiving* instrument; the second, a *receiving*.

All animals living on land have their eyes very similar in structure.

Is there any method by which it can be demonstrated how we see objects?

Are the eyes of land animals organized alike?

In carnivorous animals, the original principle of vision is preserved, but most curiously modified, according to their habits and characters.

Those that live by violence have the power of seeing in the dark.

Fishes, by a further modification of the original apparatus, probably see distinctly in the darkest night.

With another alteration, not unlike changing the distances between the lenses of a spy-glass, another family, as seals, &c., see alternately in two elements. Still further, on the descending scale of creation, insects are provided with motionless eyes, giving them the faculty of seeing in every possible direction. And, lastly, in snails and some kinds of worms, the eyes are fixed at the extremity of movable feelers, adapting them to different focal distances; or they can be drawn entirely within the head, for safe keeping, when not in use, precisely on the principle of care that we draw out the slides of an opera glass, and close them up again, when no longer needed.

THE SOCKET IN WHICH THE EYE ROLLS.

Several thin pieces of bone assist in the formation of the orbit, which, in a dry skull, is shaped much like a pear, with its large end turned outward. The upper plate of bone is arched, having the brain resting on it above, and the eyeball moving under it below. Externally, the eyes are at considerable distance, but the inner termination of the orbits, answering to the small end of the fruit, are quite near together. At their points is a ragged hole, in each, through which the nerve of vision enters the brain. A large quantity of fat is deposited in these sockets, between the bones and eyeball, that the latter may always move with perfect freedom, and without friction, in all directions. After a long sickness, the

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What class of animals can distinguish objects in the dark?
Do any animals see in both air and water?
How, having motionless optics, are those possessing them enabled to perceive objects?
What was the apparent design in furnishing some of the lower orders with eyes at the extremities of feelers or retractile tubes?
How is the orbit or eye socket constituted?
What organ rests on a thin plate of bone directly above the eye?
Where does the nerve of vision enter the orbit?
Why is the socket filled with adipose substance?

cushion of fat is absorbed, with that deposited in the bones, to sustain the system, which accounts for the sinking in of the eye. As the person recovers, the stomach resumes the task of taking care of the body, the fat is deposited again, and the eye becomes prominent as before.

GLOBE OF THE EYE.

When detached from the surrounding parts, the eyeball does not appear exactly round: it is, in outline, more than two thirds of a large sphere, with a portion of a lesser globe laid upon it.

The use of this arrangement is obvious. If the ball had been actually round, the compass of vision would have been very limited: as it is, the smaller portion, by its short curve, protrudes so far beyond the socket, where the globe is lodged for safety, that the sphere of vision is very much enlarged.

MUSCLES OF THE EYE.

To move the ball, *muscles* were necessary; otherwise, animals would be obliged to turn their bodies as often as an object was to be seen. Of these, four are straight, going from the sides of the ball, to be fastened near the hole, at the termination of the bony cavity: their office is to hold the eye firmly, in a fixed position, as in steadily contemplating a painting. Two others are given, making six in the whole, to express, principally, the passions of the mind; they are denominated the *oblique*, in consequence of their oblique movement of the eye. One rolls it upward and inward, as in viewing a button midway on the forehead; the other, going through a loop, carries the globe downward, and is so purely mechanical, that it has been the theme of admiration among philosophers in all ages. The last action may be shown by looking at an object laid on the shoulder. Although these oblique

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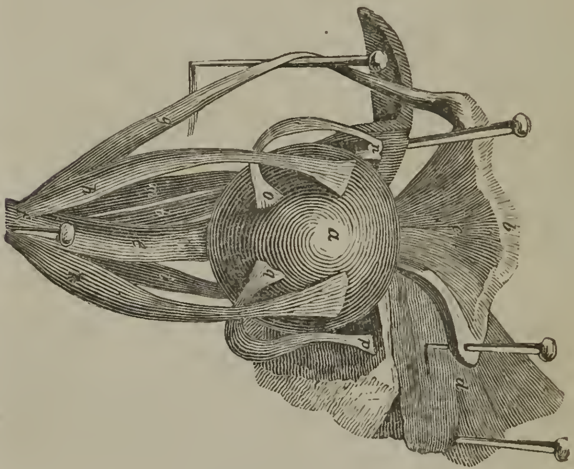
What becomes of the fat in case of protracted illness?
Is the eye a perfect globe?
Why is a portion of a small sphere laid upon a large one, as noticed in relation to the cornea and ball of the eye?
Explain the principle of having one portion protrude into the field of vision?
How is the eye moved in the socket?
How many muscles are attached to the globe?

muscles exist in monkeys and nearly all tribes of quadrupeds, they are imperfectly developed; showing most conclusively that they were designed for expressing the feelings and passions of man—an ineffable language, which all the brute creation have the sagacity to understand. When one of the four straight muscles is shorter than its fellow on the opposite side, it produces the *cross-eye*, or squinting.

Fig. 81.



Explanation of Fig. 81.

This plan exhibits the muscles, viewed obliquely from the upper and outer side of the right eye.

a, The eyeball.
b, Part of the upper eyelid.
c, *Tunica* conjunctiva, or continuation of the common skin of the forehead, which turns over the edges of the lids, and is finally carried over the front of the globe, but perfectly transparent at this point.
d, The integuments of the right side of the nose.
e e, The optic nerve.
f, The four *straight muscles*, with the *levator* or *raising muscle* * of

* There are persons wholly destitute of this elevating muscle of the upper eyelid, who, in looking at an object elevated above the level of their eyes, are obliged to carry the head very far back. They have the appearance, ordinarily, of being attentively engaged in viewing something

Have any of these an influence upon facial expression?
How is squinting, (strabismus,) or, as more commonly called, cross-eyed, produced?

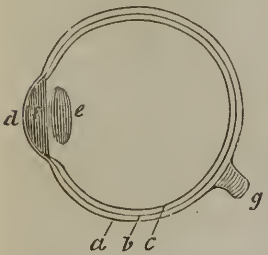
the upper eyelid, together with the *superior oblique muscle*, embracing the optic nerve where it enters the orbit.

g, The levator of the lid drawn aside.
h, *Levator oculi*, or superior straight muscle, to roll the ball upward.
i, *Abductor oculi*, rolls the ball outward.
k, *Adductor oculi*, rolls it towards the nose.
l, *Depressor oculi*, rolls the ball downward, towards the cheek.
m, The *superior oblique* muscle passing through the loop at *n*.
n, Called the *trochlea*, or pulley, but, in fact, a simple loop.
o, Insertion of the *superior oblique muscle* in the eyeball.
p, The *inferior oblique muscle*, taking its rise from a bone.
q, The insertion of the tendon of the *inferior oblique muscle* in the first coat of the ball.

COATS OF THE EYE.

Such is the mechanical arrangement of the different coats or coverings of the eye, answering in use to the brass tubes of a spy-glass, that one is fitted within the other, like a nest of boxes: they are three in number.

Fig. 82.



Explanation of Fig. 82.

This is a plan of the coats, or, as they are sometimes termed, *tunics*. Reference should be made to this after reading the text. The natural figure of the eye, in outline, is preserved.

a, The *sclerotic*, or first hard tunic.
b, The *choroid*, or fleecy tunic.
c, The *retina*, or third and inmost tunic, which is an expansion of the optic nerve *g*, the certain seat of vision.
d, The *cornea*, or prominent, transparent circle, over which the lids close in winking.
e, The *crystalline lens*, or little magnifying glass of the eye, about a quarter of an inch in diameter.
f, Is the space filled by one of the fluids of the eye, and called the *anterior chamber*.
g, The stump of the optic nerve, which is prolonged into the substance of the brain.

1st. The first is the *sclerotic** coat, thick, firm, and possessing but little sensibility. Its hardness gives

at their feet. I knew two sisters who were wholly without the levator muscles, and, what was still more remarkable, neither of them could possibly bend the back or neck. It was the opinion of medical men that the spinal column in both was a solid, bony pillar, a perfect ossification of the twenty-four blocks of which the spine is composed having taken place soon after birth.

* *Sclerotic*, from a Greek word meaning hard.

How many coats has the eye? What is the external white one called?

security to the delicate membranes beyond; affords attachment for the muscles; and by its elasticity equally distends the ball, that none of the humors may suffer from pressure. Happily the hard coat is very rarely diseased. Fishes have a sclerotic coat strictly hard, being either cartilaginous or firm bone, graduated in this respect according to the depth to which they descend in search of food. Through this coat, in what is called the white of the eye, the oculist plunges a needle to cure some kinds of blindness.*

2d. *Choroid* † is the name of the second coat, having a dark red color, and apparently slightly connected with the first. By carefully cutting off the sclerotic from a bullock's eye, with scissors, the choroid will be beautifully exhibited, sustaining the humors. Minute dissection, under a microscope, shows that this tunic is a complete web of arteries and veins; hence its reddish hue. Between this and the sclerotic, fine silvery threads are seen, which hold a control over the *iris*, yet to be described, determining by their influence how much or how little light may safely be admitted into the eye. The inside of this membrane resembles closely woven wailed cloth, having a fleecy nap, similar to velvet, called *tapetum*.‡ This tapetum is particularly interesting in a philosophical point of view, as on its shade of color, in a great measure, as will be more fully explained in the sequel, depends the power of seeing in the dark.

* The eye of the great man-eating or white shark appears like a bony shell, being three and four and a half inches in diameter, according to the dimensions of the fish. When young, the sclerotica or bony box is in two pieces, which afterwards unite by a suture. In the horse-mackcrel, the sclerotic coat is also bone, but elongated into a sort of tube about the entrance of the optic nerve. In this there is a deep cavity for the lodgment of some apparatus belonging to the organ, not at all understood. It is highly probable that it has some influence on vision in deep water, in those unexplored regions of the sea where man cannot go, and where scarcely any other than the horse-mackerel is fitted to exist.

The sclerotica of the owl's eye is supported by bony ribs, like those in an umbrella, most beautifully arranged.

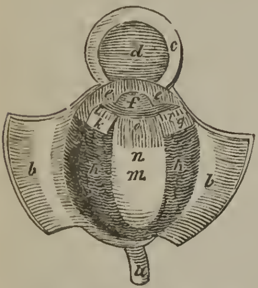
† *Choroides*, like a lamb-skin, fleecy.

‡ *Tapetum*, resembling cloth, called tapestry.

Why has it this name?
Has it much sensibility?
Is it liable to become diseased?
What is the character of this tunic in fishes?
How should you know it by examining the living eye?
Name the second coat.
Can it be exhibited?
What is the process?
How does it appear to be constructed?
What is the fleecy nap called?

3d. *Retina*,* so called from its resemblance to a net, completes the number, being the innermost and last. Its color is that of gum arabic, or ground glass. Nothing can be more delicate, being too tender to bear its own weight. In fact, it is the expansion of the optic nerve, the immediate seat of vision. To see it well, an eye should be taken to pieces in a tumbler of water.

Fig. 83.



Explanation of Fig. 83.

This represents a dissection of a human eye, the organ being represented of the proper size.

a, The *optic nerve*.

b b, The *sclerotic coat* cut and turned outward.

c, A circular portion of the *sclerotica*, being a rim of the *white* of the eye, cut and turned upward, having in its embrace the *cornea*.

d, The *cornea*.

e e, One half the *iris*, in its place, the other half being removed.

f, The *pupil*, soon to be described, with the *crystalline lens* in its place.

g, The *ciliary circle*, or second vertical partition, within the eye, behind the iris.

h h, *Choroid* coat.

i, The *ciliary processes*, or ruffle-like plaits of the ciliary circle, yet to be explained. A small portion of the iris is cut away to show them.

k, A portion of the *iris* cut and turned back.

l, The floating points of the *ciliary processes*, also turned back.

m, The middle smooth part of the *retina*, seen by cutting a hole through the choroid coat.

n, The roots of the ciliary *processes*, to which the black paint, secreted by the tapetum or inner surface of the *choroides*, adheres.

o, The *ciliary processes* inserted into the sac which contains the *crystalline lens*.

THE CORNEA.

Anteriorly, that clear, shining wall, resembling a watch crystal, which furnishes the membranous box, is called the *cornea*. Simple as this thin crystal appears, it is infinitely curious in structure. It is made of thin pellucid plates, one over another, held together by a spongy

* *Retina*, a net.

Of what use is the tapetum in the economy of the eye?
The name of the third coat?
What is it supposed to be the expanded extremity of?
Were you wishing to demonstrate its delicate structure, how would you do it?
Point out the cornea.

elastic substance. By maceration in water a few hours, the sponge will absorb it to such a degree, that the plates may be distinctly felt to slide upon each other, between the thumb and finger.

Little glands, like bags of oil, only to be seen by the most powerful microscope, are lodged under the first plate, which are continually oozing out their contents upon the surface, which gives the sparkling brilliancy to this part of the eye. As death approaches, this fluid forms a pellicle, like a dark cloud, over the lower portion of the cornea. This formation is taken to be a sure indication of approaching dissolution. See Fig. 82, letter *d*, and Fig. 83, letters *c* and *d*, for representation of the *cornea*.

IRIS.

By looking into a person's eye, there seems to be a vertical partition, either black, blue, or hazel, as the case may be, which prevents us from looking into the regions beyond, having a round hole in its centre. This is the *iris*, while its central orifice is denominated the *pupil*. How the diameter of this hole is enlarged or diminished, has never been explained satisfactorily. One fact, however, is certain, that the pupil is large or small, according to the quantity of light that may be necessary to the formation of a distinct picture of the object seen, and this change is effected without our being conscious of the action.

From the reflection of such rays as are not admitted through the pupil, or central hole, we account for much of the lively brilliancy of the iris. On its back side it is rather fleecy. Over this is spread a black, blue, hazel, or tea-colored paint, which gives a permanent color to the eye. It has been remarked, that the eyes and hair ordinarily correspond in color. Whenever the iris acts, as,

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How are the several membranes of which it is composed held in contact?
Has the external one any thing extending through it?
For what purpose is this oily excretion?
Show me the iris.
What prevents us from viewing the interior of each other's eyes?
What is the pupil?
Are we conscious of the action of the iris?
Has the iris a coloring matter or pigment?
On what does the color of the eye depend?

for instance, it does in going from a dark into a light room, the pupil is made smaller, acting uniformly in its fibres, to keep it circular. On returning to the dark apartment, the pupil enlarges again. A knowledge of this fact will explain the reason of a painful sensation in the eye, caused by a strong and sudden light. As soon as the iris has had time to diminish the size of its pupil, we can endure the same luminous object with perfect comfort. When we leave a well-lighted room, on first going into a dark street, every thing appears lurid and indistinct. The iris soon begins to enlarge the pupil, to admit more light, and when that has been accomplished, although in comparative darkness, we recognise objects without an effort. Acting independently of the will, its duties are like those of a faithful sentinel, always consulting the safety of the splendid optical instrument confided to its care, with reference to its subserviency to the being for whose use it was exclusively constructed. Were it otherwise,—were it left to our own care, how often it would be neglected, and, indeed, totally ruined, solely for the want of undivided attention.

Parrots have a voluntary control over the pupil, opening and closing it at pleasure. How this is done, or why, in the constitution of that bird, it is necessary, we cannot determine. Cats, also, appear to have a similar power of graduating the quantity of light admitted into their eyes, as it suits their own convenience.

In carnivorous quadrupeds, the pupil is commonly oval and oblique, permitting them to look from the bottom to the top of a tree without much elevation of the head. Graminivorous quadrupeds have an oblong pupil, placed horizontally, with respect to the natural position of the body. This form gives them the faculty of surveying the expanse of a field at once. See Fig. 83, letters *e*, *e*, and *k*; Fig. 84, letters *c*, *c*.

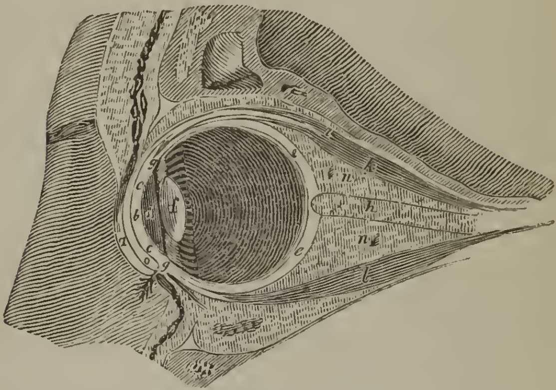
CILIARY PROCESSES.

Directly behind the iris is a second curtain, having a

How is the diminution of the pupil effected?
Why can we not perceive objects readily on going from a lighted room into the dark?
Is the pupil under the influence of the will?
Why is the pupil not round in quadrupeds, as a general law?
Is there a second curtain within the globe?

central hole through it, corresponding with that through the first curtain, but nearly as large as the whole diameter of the lens. All the luminous rays which are converged by the convexity of the cornea, which is, in effect, a plano-

Fig. 84.



Explanation of Fig. 84.

This plan presents a longitudinal section of the left eye and orbit.

a, The upper eyelid, shut.

b, The *cornea.*

c c, The cut edges of the *iris.*

d, The *pupil* or round hole through the centre of the *iris*, which, in the living eye, resembles a black, highly polished dot.

ee, The cut edges of the *sclerotic* and *choroid* tunics, with the *retina*, before exhibited in the preceding drawings.

f, The *crystalline lens*, as it is lodged with reference to other parts.

g g, The *ciliary processes* continued from the *choroid coat.* The plaits are here distinctly seen.

h, The *optic nerve*, running from the brain, through the bones, to the globe of the eye, apparently closely embraced by the straight muscles.

i, The *levator* muscle that raises the upper eyelid.

k, The upper straight muscle of the eye.

l, Inferior straight muscle, its antagonist, on the under side of the ball, called *depressor oculi.*

m, A section of the inferior oblique muscle, used in rolling the eye upward and inward, as in looking at a button laid above the root of the nose. The *superior oblique*, passing through a loop, carries the eye downward and outward, as in looking at the top of the shoulder. These two *muscles*, by old writers, were termed *rotatores* and *amatores*, in allusion to their office of rolling the ball in expressing passions.

n n, A section of the blood-vessels and nerves, with a large quantity of fat, surrounding the *optic nerve.*

Where is it lodged, in relation to the iris?

Give the name, and describe it generally.

convex lens, cannot enter through the pupil; many of them strike the plane of the iris, and are reflected back, as on a looking-glass, without penetrating its substance. If any rays were to get through, by such an irregular process, it would produce great confusion, by destroying the outline and vividness of the image previously made on the retina, through the natural opening. To prevent such mishaps, the paint on the back of the iris is to absorb such rays as are not reflected, and have a tendency therefore to pass onward. Nature, as though fearful that circumstances might so alter the condition of the pigment,* as that some light, notwithstanding this precaution, might penetrate, has interposed this second veil, solely, it is supposed, to stop all wandering rays.

This ciliary curtain presents three thicknesses, and, lastly, has a thick coat of black paint on its back. In order to give it treble security, as it regards thickness, it is plaited like the folds of a ruffle. There are seventy folds in the human eye, of equal width, nicely laid, one over the other. A part so highly important cannot be overlooked in studying the philosophy of vision.

HUMORS OF THE EYE.

By humors, writers mean the fluids which distend the eyeball. They are three in number, possessing different densities, and varying much in quality, quantity and use. Besides fulfilling the first intention,—viz. distension,—they are so purely transparent as to offer no obstruction to the free passage of light. Those only interested in this description as general scholars, by close examination, will have a perfect idea of them, and will consequently understand the real nature of some of the many causes that weaken the power of vision, or ultimately produce a total blindness. The gratification afforded by the examination of a bullock's eye, tracing the several parts by

* Pigment, *paint*.

Has it an orifice?
Does it open and close, as does the pupil?
What injury would it do, were rays of light to be admitted into the eye through the walls, as well as pupils, at the same time?
Of what service is the pigment on the back of the ciliary processes?
What do you understand by the humors of the eye?
How many are there?
Are they of equal density?

this paper, will be an ample compensation for the labor, because it will forever fix on the mind interesting facts, and lead the reader, insensibly, to a course of reflections, productive of much intellectual enjoyment.

AQUEOUS HUMOR.*

The aqueous humor is the first in the order of demonstration, lying directly back of the cornea, so clear, that one unacquainted with the existence of it would not suspect a fluid there. In volume, it is far less than the others. It keeps the cornea prominent, always at the same distance from the iris, in the early periods of life. The space occupied by the aqueous humor is called the *anterior chamber* of the eye. (See Fig. 82, letter *f*.) Passing freely through the pupil, it also fills an exceedingly thin apartment, the circumference of the iris, called the *posterior chamber*. Thus it will be comprehended that the *iris*, or, in familiar language, first curtain, is actually suspended and floating in a liquor.

Were it not for such a contrivance, the iris would soon become dry and shrivelled, by the intensity of the sun, and therefore rendered totally unfit to perform its appropriate office of opening and closing the pupil. The aqueous humor is never suffered to remain long at a time, but, on the contrary, is constantly poured in and again drawn off by an infinite number of invisible ducts. By being stationary, it would become speedily turbid, and finally lose its transparency. A knowledge of the rapidity of the secretion has been the means of encouraging oculists to undertake novel methods of extracting cataracts, a kind of dark mote, through the cornea, as the most certain mode of restoring sight. Twenty-four hours after drawing off the aqueous humor, by a puncture, the anterior chamber will be full again.

Old age, characterized by a gradual decay in the vigor

* Aqueous, *like water*.

Where is the place of the aqueous humor?
Is it equal in volume to the others?
The anterior chamber?
Is any thing suspended in this humor?
Were the aqeuous humor drawn off, what would be the effect on the iris?
How frequently is this fluid renewed?
Would any injury accrue to the organ if it were not renewed at all?

of all the individual organs, shows also its insidious approach in the eye. Vessels that have toiled with untiring diligence to the meridian of life begin to show a loss of energy. Those which have carried the new, pure liquid, supply a less quantity in a given time than formerly, while those whose task it was to convey away the old stock are dilatory in the performance of their work. Hence, from being kept too long in the reservoir, in consequence of a tendency to become more turbid, it does not allow the light to pass with its former facility to the nerve; elderly persons, therefore, have indistinct vision from this cause, similar to looking through a smoky atmosphere. Fishes have no aqueous humor at all, as it could be of no service in the element in which they swim.

Kept, as the humor is, in its own capsule, it gives other advantages to the apparatus of vision: it is a concavo-convex glass, absolutely and indispensably requisite in an instrument that will produce an image by the same laws that govern the eye. A sensible diminution in the quantity of this fluid is very apparent in people advanced in years: the cornea becomes flatter; the segment of it is so altered, that rays of light are no longer converged, as in younger days. This, together with corresponding derangements within the globe, constitutes the long-sightedness of old age,—mechanically overcome by wearing convex spectacles. So gradually are the changes wrought by age, that glasses of different focal distances are sought from time to time, to keep pace with the progress of decay.

The ingenuity of man is nowhere more curiously displayed than in thus availing himself of his discovery of the laws of refraction, in producing artificial lenses to gratify his eye, a never-failing source of enjoyment, long after nature has begun to draw the blind that will ultimately close between him and the world forever.

Have fishes an aqueous humor? Why not?
What is the condition of the cornea in age?
How is the long-sightedness of old age produced?
Do these changes take place suddenly?

CRYSTALLINE LENS.*

As magnifying glasses of different refractive powers give perfection to optical apparatus, so it is with respect to the lenses within the ball. By *crystalline lens* is simply meant a body like a button, resembling pure flint glass, somewhat of the shape of a common sun glass, convex on both sides. Its posterior convexity is greater than its anterior, thereby bringing the rays to a point a little distance behind it. Careful investigation shows that this lens is made of a series of plates, applied to each other like the coats of an onion: the centre is firmer than the edges.

As a whole, it possesses a highly refractive property, but in different degrees, according to the thickness of the lens, receding from the centre to the circumference. Over the whole, to keep it from sliding in any direction, that the centre may not get without the axis of vision, is an envelope, having connexion with all the coats, where they are united on the borders of the cornea, and where it joins the white part of the eye. Being equally transparent with the lens itself, it cannot be conveniently exhibited.

Cataracts, the most frequent cause of blindness, origi-

Fig. 85.

Explanations of Fig. 85.

This plan represents an eye surrounded by its natural appendages, with a knife passing through the anterior chamber. A dotted line indicates the lower edge of the flap, made by cutting off just one half the cornea from its attachment with the sclerotica, in order to allow the crystalline lens to escape whenever the knife is withdrawn.

* *Crystalline lens*, resembling crystal or glass.

What is the next humor?
Describe its figure.
What is its office?

How is it kept in place?
Is its refractive property equal in every part?

nate in the lens; sometimes half way between the centre and margin, but ordinarily in the centre. They are either a peculiar deposition of opaque or milky matter, entirely preventing the ingress of light, or there is an opacity of some of the internal layers of plates, equally destructive to vision. Many children are born with this affection; and at all ages they are liable to form. To remove cataracts by extraction, the operator slides a sharp, thin knife, resembling a lancet, through the cornea, from one side to the other, cutting one half from its natural attachment, leaving it in the form of a flap. See Fig. 85.

As a matter of course, the aqueous humor escapes in a twinkling; at the same moment, the capsule of the lens, previously ruptured, designedly, by the point of the knife, as it slides along, acts upon the lens by spontaneous contraction, and protrudes it through the wound. Undoubtedly the grasp which the straight muscles have on the ball accelerates its escape.

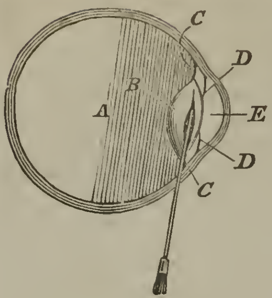
Thus, in taking away the obstruction to sight, the whole lens is extracted.

To *couch*, an operation often mentioned, and often performed, is to thrust a delicate needle through the white of the eye, just on its border, till the point reaches the lens, which is then depressed into the lower part of the eye, below the optic axis, so that light may, by entering the pupil, arrive at the nerve. In this last operation, fears are always entertained that the lens may rise again to its former position, rendering a repetition of the operation indispensable. *Secondary cataracts* sometimes form, after couching or extraction, and arise in consequence of a thickening and opacity of the capsule, which is left behind. Such cases are more alarming in their progress than a disease of the lens, as no surgeon is warranted in promising even a partial relief. If he attempted to tear away the membrane, he might also rend every other within the globe.

A few facts of this kind which have a practical bearing, more or less interesting to every person, may lead to correct views in relation to some of the diseases which are common to this curious organ.

Where do cataracts occur?

Fig. 86.



Explanation of Fig. 86.

This is a scheme showing how a bad operator, by introducing the couching needle too near the cornea, may rupture the ciliary processes, and actually divide the lens in two pieces, without moving it from the optic axis.

A, The *vitreous humor*.

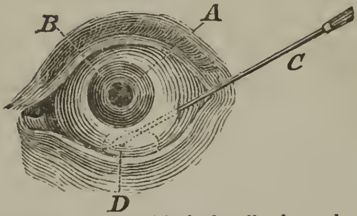
B, The *lens*.

C C, *Ciliary processes*, torn by the lower part of the needle, thereby doing great violence and a permanent injury to the organ.

D D, The *iris*.

E, The anterior chamber of the aqueous humor.

Fig. 87.



Explanation of Fig. 87.

This figure represents the mode, and, in fact, the place into which the couching needle is introduced in the operation of couching.

A, The pupil is seen through the transparent cornea.

B, The *iris*.

C, The needle, with the handle elevated so as to depress the point.

D, The lens and point of the needle in outline. This precisely represents the position of the lens after couching.

VITREOUS HUMOR.

Beyond the two humors we have been describing is the third, differing essentially from either of them. In volume it far exceeds the others, occupying more than two thirds of the whole interior of the ball. Its consistence is that of the white of an egg, but kept in place by its own capsule. When the sac is punctured with a pin, it flows out slowly, in consequence of its adhesiveness. Like the preceding humors, it is transparent, allowing the free passage of light through its substance, and also possesses the additional quality of allowing the rays to separate again, as they leave the point at which they were converged just back of the lens. Observation proves that

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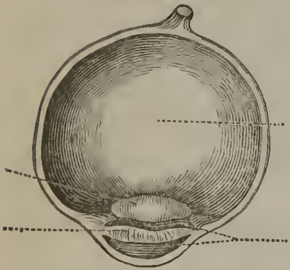
The name of the third humor?
Does it exceed the others in quantity?
Is it transparent?
Describe its general structure.

the vitreous humor is kept in place by being lodged in cells. Perhaps a piece of sponge might give a tolerable idea of the cellular structure, admitting it to be as transparent as the water which it absorbs. On its fore part it has a depression, in which the posterior convexity of the lens is lodged, as represented in this diagram. Concave, therefore, in front, and convex behind, gives another kind of optical glass, known as the *meniscus*,—the crescent, faintly resembling the first quarter of the new moon.

Fig. 88.



Explanation of Fig. 88.

One dotted line indicates, in this diagram, the aqueous humor; another the iris, and a third the lens, and the fourth the vitreous humor. Let it be remembered that all the space between the back side of the lens and optic nerve is filled completely, with the glairy, vitreous humor, the third fluid, and inmost of the eye.

OPTIC NERVE.

Any person, possessing an ordinary share of curiosity, can examine the *optic nerve* at leisure, in slaughter-houses, fish markets, and in fowls. In the human eye, or rather extending from the globe to the brain, the optic nerve is very much like a cotton cord, somewhat larger than a wheat straw, of a mealy whiteness, and not far from three quarters of an inch in length. Arising from the substance of the brain, it traverses the bony canal till it reaches the back of the eyeball; as soon as it arrives in contact, as it were, it is suddenly divided into innumerable filaments, which wend their way into the globe, through very minute holes. From a fanciful resemblance to a sieve, this spot on the sclerotica is called the *cribriform* plate. When the threads have emerged within, they assume another form, by expanding into a web, constituting the third or inmost box. Some believe the nerve

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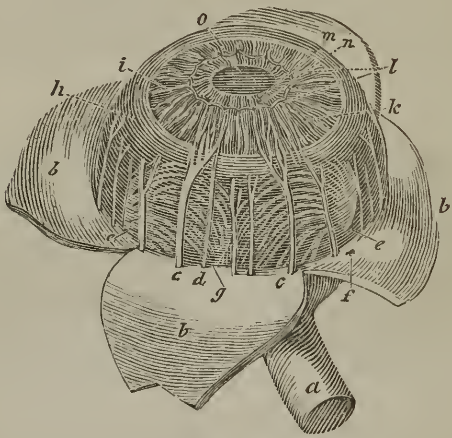
Does it resemble an optical glass of any kind?
Where does the optic nerve arise?
Where terminate?
Is this the medium of communication between the eye and brain?

is spread on a thin, *unseen* membrane, in the form of a highly organized nervous paste. Here, on this pulp, having considerable range of surface, is the sole seat of vision. A vulgar opinion presupposes some exceedingly acute nervous point, the exquisite place of vision. No-

Fig. 89.



Explanation of Fig. 89.

In this figure, the *cornea* is cut away, and the *sclerotic* dissected back. This is a beautiful and easily accomplished dissection. In a bullock's eye all these delicate nerves can be readily displayed. A pair of sharp pointed scissors and a few pins, to hold parts to a board, are the proper instruments. In schools, ladies could display the whole of this beautiful optical apparatus.

a, The *optic nerve*.

b, The *sclerotic coat* turned back, so as to show the vessels of the *choroid* coat.

c c, The *ciliary nerves*, seen piercing the *sclerotic coat*, and passing forward to be distributed to the *iris*. The *iris*, so highly organized, is not supplied by any nervous influence from the *optic*, but by the hair-like nerves, here displayed, creeping to its margin between the two exterior coats.

d, A small nerve passing from the same source to the same termination, but giving off no visible branches.

e e, Two *venæ vorticosæ*, or whirling *veins*, so denominated because they seem to fall into shapes resembling falling jets of water; these return the blood from the eye, sent in by its central and other arteries.

f, A point of the *sclerotic*, through which the trunk of one of the veins has passed.

g, A lesser vein.

h, The circular point of union, where all the coats of the eye, together with the cornea and iris, seem to be glued firmly together.

i, The *iris*.

k, The *straight fibres of the iris.*
l, A circle of fibres or vessels, which divide the iris into the larger circle *k*, and the lesser one *m*.
m. This letter points to the lesser circle of the *iris*.
n, The fibres of the lesser circle.
o, The pupil.

thing, however, is more absurd; vision includes considerable surface. In the centre of the substance of the nerve, an artery penetrates the eye, accompanying the *filaments*, to nourish the humors. When the cornea has been cut away, and the iris detached, this vessel may be distinguished, of a bright scarlet, spreading its hair-like branches about, like the limbs of a tree. The nerves which give sensation to the eye, connecting it with the system, may be noticed, as previously remarked, lying between the two first coats. The optic nerve conveys to the mind the sensation of the existence of things, as perceived by the eye, while the *commands* of the same mind are conveyed to the organ by these little threads of nerves, so insignificant as to be often overlooked in a dissection made purposely for them.*

PIGMENTUM NIGRUM.†

Lastly, to complete the internal structure, and fit it for the performance of its destined office, the inside surface of the second coat, *choroides*, is thoroughly painted black. In the order of explanation, this paint is just behind the retina. When the humors have been taken out, the pig-

* Some extraordinary cases of clairvoyance are recorded in the Boston Medical and Surgical Journal. Miss Rider, of Springfield, could play games of chance perfectly blindfolded and Mrs. Carr, at Stanstead, Lower Canada, in a recumbent position, being in a dark room, saw persons in an adjoining apartment distinctly, described their dresses, and even told the time by the watches in their pockets. A female in Uxbridge, more recently, laboring under a similar disease with which the others were affected, not only saw things as they did through thick walls, but her vision became both microscopic and telescopic. She was disgusted and shocked at the monsters she saw in various fluids, and charmed with the wonders of the distant firmament. M. Poyen, in the course of his researches on animal magnetism, has recorded similar facts, which still remain unaccounted for.

† Pigmentum nigrum, *black paint.*

Is there a blood-vessel inclosed by the optic nerve?
Of what utility is it within the eye?
Where are the ciliary nerves lodged, on which the general sensibility of the eye, as an organ, depends?
Does the optic nerve convey any sensation to the mind, other than that produced by the impression of light?
Where is the pigment found?

ment is readily examined. The use of it is very obvious; viz., to absorb any aberrating or unnecessary rays of light, which would confuse the vision, or destroy the intensity of the impression on the expanded retina, or to *suffocate* them entirely.

SKIN OF THE EYE, OR TUNICA CONJUNCTIVA.

Behind, the eye, by its long cord of optic nerve, seems to rest on one extremity of an axle: in front, the skin, passing over the eye, as it comes down from the forehead, to join the cheek, is the other.

To comprehend clearly the manner in which the eye is fastened before, observe how the skin turns over the edge of the lid, going about three quarters of an inch back, striking the ball, to which it is made fast, then folded back upon itself, adhering to the whole anterior surface of the cornea, dipping down and finally mounting over the margin of the lower lid, and ultimately losing itself on the face. As we cannot recognise this on a living eye, it will at once lead one to suppose it as clear as glass, which is the case. Streaks of blood, when the eye is inflamed, lie covered over by the tunica conjunctiva. Now if particles of sand, or other irritating substances, get under either eyelid, they cannot possibly enter but little way, before reaching the duplication of this transparent skin; there is no danger, therefore; the offending matter cannot get so far between the socket and ball, backward, as to abridge the free motion of the organ, or do a permanent injury to the parts. This partition, or doubling over of the conjunctiva, is a curious provision, as we are thereby enabled to reach the source of irritation.

The principle of introducing eye-stones to extract foreign matter is this, and not owing, as vulgarly supposed, to the crawling about of a smooth piece of sulphate of lime, on some forty or fifty feet. The stone is so much larger than the extraneous body already there, that it excites a proportionably larger quantity of tears, to wash it away: in effect, therefore, we submit to a greater temporary evil, to get rid of a lesser one.

What is the object of it?
What is the conjunctiva?
Describe its connexion with the eye.
What prevents particles of matter from reaching the backside of the globes within the orbit?

Serpents annually shed their skins, which, unaccountable as it at first appears, are whole over the eyes. That thin sheet, so very clear and fine in texture, is the conjunctiva, showing its origin; hence a similar origin may safely be inferred over other eyes. Every species of animal, with which naturalists are conversant, possess this defensive transparent membrane.

THIRD EYELID, OR MEMBRANA NICTITANS.

A third eyelid is given such animals as are destitute of hands, or are incapacitated, by the arrangement of their limbs, from reaching their eyes. This is called membrana nictitans, and a more striking piece of mechanism there is not in existence. It slides from one angle of the eye to the opposite one, under the first pair of lids, and that, too, whether the others are open or shut, being totally independent of them in muscular action. Its use cannot be mistaken: it is on purpose for clearing away matter that may be irritating to the eye. Any extraneous substance is brushed from the cornea in an instant, by the broad sweep of the night lid. Birds that seek their food

Fig. 90.

Explanation of Fig. 90.

a, is a representation of an eye partly covered by the *membrana nictitans*. The second figure exhibits the backside of the same eye, where the mechanical arrangement of the muscles is plainly shown. *b*, is a broad radiated muscular sheet, curiously operated upon by a second muscle, the fleshy part of which is marked *d*, and its long, slender tendon *c*. The fulcrum or fixed point of the muscle *b*, is varied by the contraction of *d*, in order to draw or withdraw the nictitating veil on the opposite side of the organ.

By defending their eyes with this attenuated curtain, owls sit perched on the limb of a tree through the day, looking at the sun. They distinguish the light, though they cannot perceive objects distinctly.

By opening the eyelids of a dog while sleeping, this membrane may be seen covering the cornea. Eagles, hawks, gulls, and other birds which fly high in the air, undoubtedly defend their irritable organs from the glare of light at great elevations, by this eyelid, when on the wing.

Have serpents a similar membrane?

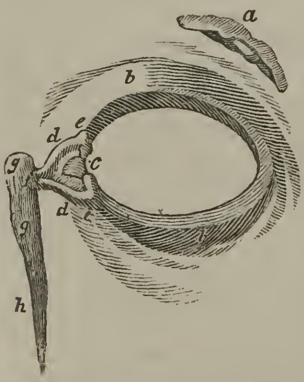
The utility, to brutes and birds, of a third eyelid?

in the night, as owls, defend their irritable organs through the glare of daylight by drawing over this singular curtain. Dogs, cats, foxes, wolves, bears, lions, tigers, &c., can each of them, by this brush, remove the minutest mote from the cornea, more expeditiously than any oculist on the globe.

TEARS.

Perfection is everywhere observed in animal mechanics. The eye would soon become a useless instrument, notwithstanding the nice adjustment of its several parts, were it not for the external apparatus of eyelids, glands and tears, whose combined action keeps it always in a condition to be useful. Were not the cornea frequently moistened, it would become dry and shrivelled. To obviate this, a sack of fluid is fixed just under the edge of the orbit, above the eyeball, which is continually pouring out its contents by the pressure and rolling of the eye. Flowing through numberless apertures, it washes the crystal, and finally, passing into grooves, on the inner

Fig. 91.



Explanation of Fig. 91.

This plan exhibits the natural size of the passages of the tears.

a, Is the lachrymal gland, or organ that secretes the tears; showing its natural situation, with respect to the eyelids.

b b, The eyelids widely opened.

c, The situation of the *puncta lachrymalia*, or the holes at the inner angles of the lids, through which the tears flow to get into the tube which finally conveys the fluid to the nose.

d d, The ducts continued from the *puncta lachrymalia*.

e e, The angles which the ducts form after leaving the puncta.

f, The termination of the lachrymal ducts in *gg*.

gg, The lachrymal sac.

h, The nasal duct continued from the lachrymal sac.

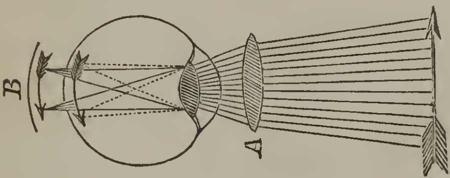
Use of the tears?
Where is the sac that secretes the tears?
After having flown over the cornea, what becomes of this fluid?

margin of both eyelids, runs to their terminations in a small pin-like orifice, at the inner angle. To keep them open, a hoop is set in the mouth of this tear tube. This, too, can be shown by turning the lid outward by the finger. Finally, the tears are conveyed into the nose through a bony tube, answering the double purpose of keeping moist the lining membrane, on which the sense of smell depends. On both eyelids, at the roots of the eyelashes, are in each a row of glands, equivalent to bags, smaller than pin-heads, which pour out an oily secretion, to prevent the adhesion of them together, as is sometimes the case when the eyes are much inflamed. Surely such manifest provision for contingencies is another beautiful illustration of superhuman contrivance.

WHY DO AGED PERSONS REQUIRE CONVEX GLASSES?

Age gradually relaxes the tension of the whole system; the eye, therefore, suffers in a corresponding ratio. The cornea becomes less prominent: the convexity of the lens is also diminished, and the rays of light are consequently less convergent than formerly. The picture of the object is faint, because the rays have a tendency, by their di-

Fig. 92.



Explanation of Fig. 92.

In this figure is represented the effect of old age on the humors. Without the intervention of the glass A, the rays have a direction which would form the image at some distance beyond the *retina*, as at B. But, by the convex glass A, which, for example, is the spectacle worn by aged people, the *direction* of the rays of light is so corrected, that the image falls accurately on the bottom of the eye, or *retina*.

Of what use in the nasal cavities?
What prevents the adhesion of the eyelids during sleep, or when greatly inflamed?
Why do the aged require convex glasses?
Why is the picture of objects less distinct than in youth?
Are the powers of the system, and particularly the organs of sense, feeble in age?

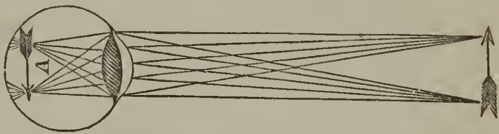
vergency, to impinge at a supposable plane, beyond the retina.

When the convex lens is interposed between the eye and object, as represented in the above diagram, the rays are made more converging, so that the picture strikes exactly and distinctly on the nerve. People slide their spectacles on the nose, unconsciously, till the true focus is procured.

WHY DO NEAR-SIGHTED PERSONS SEE INDISTINCTLY ?

Either the crystalline lens, but more generally the cornea, is too prominent, converging the light too suddenly; that is, converging the luminous rays at an unnatural place within the vitreous humor. An indistinct outline of the object is the effect of their great divergency after decussating, before they arrive at the retina. The following diagrams will illustrate the subject far better than a whole volume of written explanations.*

Fig. 93.



Explanation of Fig. 93.

In this figure, the convexity of the cornea, or the focal powers of the lens, being too great for the length of the axis of the eye, the image is formed at A, before the rays reach the surface of the *retina*, or inner box, illustrated in Fig. 82, letter *c;* and after coming accurately to the point, they again begin to diverge; which diverging rays, striking the surface of the retina, give the indistinct vision of the near-sighted individual. But as this indistinctness of vision proceeds from no opacity, but only the disproportion of the convexity of the eye to the diameter, the defect is corrected by a concave glass, represented in the next figure.

* A series of models were devised by the author a few years since, illustrating every part of the mechanism of the eye and ear, on a very large scale. The length of the model of the ear, from the external orifice to the inner point of the temporal bone, where the acoustic nerve enters the labyrinth, exceeds two feet.

These are now extensively manufactured by Mr. Joseph Brown, Washington street, Boston. They have become necessary apparatus in a

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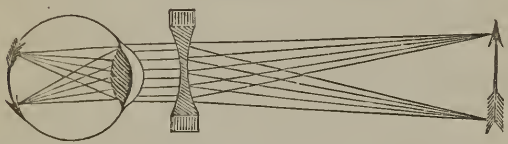
How does a convex lens correct the vision?

What is the course of some of the causes producing near-sightedness?

Can you draw a diagram to illustrate the principle?

Concave glasses are the restoratives of the near-sighted eye, by separating the rays, and carrying the image so far back as to place it on the retina. Old age, the destruction of the first eye, eventually restores the near-sighted, by the gradual flattening of the cornea, till, at threescore and ten, such persons can see clearly and distinctly without artificial aid. Many near-sighted people totally ruin the organ by prematurely wearing glasses, as a focus is established which neither glasses can keep pace with in age, nor age thoroughly overcome.

Fig. 94.



Explanation of Fig. 94.

The effect of this glass being exactly the reverse of the convex, it causes the rays to fall upon the surface of the eye so far diverging from the perpendicular line, as to correct the too great convergence caused by the convexity of the humors. When a near-sighted person has brought the object near enough to the eye to see it distinctly, he sees more minutely, and consequently more clearly, because he sees the object larger, and as a person with a common eye does when assisted with a magnifying glass. A near-sighted person sees distant objects indistinctly; and as the eye, in consequence, rests with less accuracy upon surrounding objects, the piercing look of the eye is very much diminished; and it has, moreover, a dulness and heaviness of aspect. Again, the near-sighted person knits his eyebrows and half closes the eyelids; this he does unconsciously, to change the direction of the rays, and to correct the inaccuracy of the image. Near-sighted people have but little expression; the countenance loses all its dignity, by habitually wearing glasses.

An incurable injury is continually being inflicted by those who are habitually applying a prospect, or, as more generally called, a quizzing glass to the eye. Those accompaniments of senseless foppery which young gentlemen and ladies take infinite pains to exhibit, of rich and costly workmanship, dangling at the extremity of a golden chain, or, if the individual's finances forbid, at the end of a yard of ribbon, have laid the sure foundation of imperfect vision, if not total blindness of one eye, in old

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majority of the seminaries, academies, and colleges throughout the New England states. Physicians and medical students would find them exceedingly valuable.

age. The eyes will not correspond after a while; or, to be better understood, two objects of different sizes are perceived, instead of one of the natural size and color.

Wearing green spectacles, another ridiculous mania, which boys of a certain class seem to imagine adds wonderfully to the dignity of their appearance, are ruinous appendages, and should be prohibited by parents, unless there is an urgent necessity for them.

In walking the fashionable streets of the principal cities in this country, or in looking into the institutions of learning, it is actually a subject of marvel to a stranger, that about one twentieth of the male youth are *decorated* with spectacles.

Now the principle of using glasses, when neither age or near-sightedness demands them, is this, viz., to intercept some one of the seven prismatic colors, which produces irritation. Green spectacles are most fashionable.

Let us examine the matter a little further, philosophically.

Because green is perfectly agreeable to the constitution of the eye, our good and benevolent Creator has made this the predominant color of the whole vegetable kingdom; green, therefore, as it respects the laws of vision, of all others is least irritating and the most required. By preventing the ingress of the green ray, vision is not perfect: nature loses much of her beauty, because every thing seems to be surrounded by a murky atmosphere.

Modern discovery has demonstrated that there are colorific rays entering the eye. Glasses which would arrest their progress, oftentimes the undoubted, though, perhaps, unsuspected source of chronic inflammation, would be of some consequence. Again, the red ray, under certain pathological conditions of the organ, is unquestionably another powerful but equally inscrutable cause of disease. *Red glasses* would only stop the red rays, as the green ones restrain the transition of the green. It follows, therefore, that the latter, indiscrimmately worn, for *effect*, which is too frequently the case, are injurious, and ought not to be used; while the red ones would be very appropriate and beneficial, under certain modifications of opthalmic affections. But no one would wear red spectacles, because they would look so singularly.

THE IMAGE OF AN OBJECT IN THE EYE IS INVERTED.

Rays of light going from the upper and lower points of an object are refracted towards the perpendicular; that is, bent out of the course which they have a tendency to run, by the crystalline lens behind, where they unite in a point, and, then crossing, diverge again. Here, then, the image is bottom upward, as will be noticed in the preceding diagrams by the arrow and its image on the retina. Decussation is indispensable to the vision of things. An object could not be represented on a point; there must be surface to create an image on; and by the laws of optics, the representation of the object, without an additional glass, within the eye, must necessarily be as it is, bottom upward.

THE OBJECT IS SEEN IN ITS TRUE POSITION.

Habit is supposed to be the cause of seeing objects as they really exist in relation to surrounding bodies. An attempt has been made to prove that the *cornea* is the true seat of vision, and that we see by means of erect and reflected, and not by refracted and inverted images. A few philosophers conceive that the mind contemplates the object only, without reference to its representation on the retina, which is made there as a natural result. Certain it is, that without the image there is no vision.

How the brain is operated upon by the light that defines the object, will probably never be known. The minuteness of the picture traced on the retina, precisely like the object in every minute particular, is truly astonishing. By cutting off the coats of a bullock's eye and holding a clean white paper near, this beautiful exhibition can be leisurely observed. If a sheet of white cotton cloth, six feet square, is elevated 24,000 feet in the air, the eye being supposed one inch in diameter, the miniature of the cloth on the retina will be only one eight thousandth part of an inch square; which is equivalent

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How happens it that the image of an object on the retina is inverted?

How is it supposed that we actually see things as they are, admitting that the mind merely contemplates the image, and not the object?

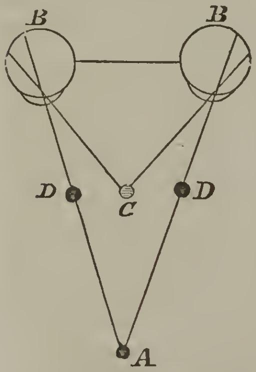
Can the change wrought on the brain by the presence of an image in the eye be explained?

to the 666th part of a line,—being only the 66th part of the width of a common hair!

WITH BOTH EYES ONLY ONE OBJECT IS SEEN.

At one side of the centre of each eye, there is a surface more susceptible of visual impressions than any other. These points correspond in both eyes, being precisely on the two retinas alike. An impression therefore on one, provided the light strikes them equally, produces precisely the same effect on both. This, instead of making vexation, gives strength and greater vividness, as the images are on surfaces of the same structure, transmitting, through the two optic nerves, the same idea, or that indescribable something that creates an idea. The optic axes, by this explanation, will be understood. If one eye is distorted, pressed by the finger one side, when we are in the act of contemplating an object, it will appear double, but less distinct in the one so distorted. The rationale is this: viz. the visual surface on which the image is made, so exactly alike in both eyes as to call up but one idea, being forced out of the optic axis, the rays still make the picture. but on a surface less highly organ-

Fig. 95.



Explanation of Fig. 95.

In this figure, B, B, the eyes, having their axes directed to A, will see the object C double, somewhere near the outline D, D; because the line of the direction of the rays from C does not strike the retina in the same relation to the axis, A, B, in both eyes. If a candle is placed at the distance of ten feet, and I hold my finger, at arm's length, between the eye and the candle, when I look at the candle my finger appears double, and when I look at the finger the candle is double.

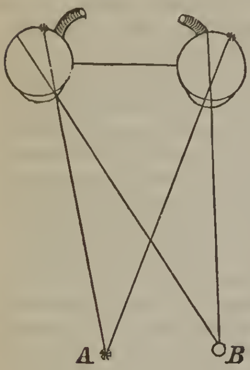
Is there any one point in the eye better adapted to visual impressions than another?

Why do we not see two objects, or have a distinct perception of two images, when looking with two eyes?

When distorting one eye, why do we have two or more objects?

ized, that does not correspond with the surface on that retina which has not been disturbed. The two images have now different localities. No course of experiments is more within the reach of the scholar.

Fig. 96.



Explanations of Fig. 96.

A is exactly in the centre of the axes of both eyes; consequently, it is distinctly seen; and it also appears single, because the form of it strikes upon the points of the retina opposite to the pupils in both eyes. Those points have a correspondence, and the object is strengthened in the liveliness of the image. Again, the object B will be seen fainter, but single and correct. It will appear so because there is only one spot in each eye which possesses the degree of sensibility necessary to perfect vision; thus, it will be understood, the object will appear single, as the rays of light proceeding from it have exactly the same relation to the retinas in both eyes.

CROSS-EYED PERSONS SEE ONLY WITH ONE EYE.

With such as have a permanent squint, (cross-eye,) only one eye is used, though they may not be apprehensive of the fact. From continued neglect, the distorted organ wanders farther and farther from the axis of vision, till it finally becomes totally useless: hence one is doubtful, at times, which way the cross-eyed person is looking, from a want of parallelism in the motions of the eyes. When the wandering eye is exclusively attended to, the vision appears unimpaired. The image is well painted in the natural one, but weak in the other, solely because the place of the image does not correspond with the place of the image in the first. The mind, instinctively, therefore, is devoted to the eye that gives the liveliest impression, to the entire neglect of its aberrating fellow.

Do squint-eyed persons see with both eyes at once?
Why does the weak eye become distorted?
Which eye is most serviceable?
Is the expression of the face influenced by this?

THE PUPILS OF AN ALBINO'S EYES ARE RED.

If a person is born without the *pigmentum nigrum*,—which is a paint that absorbs all unnecessary light after the image is formed,—the blood-vessels of which the *tunica choroides*, or second coat, is made, are not hidden; consequently, they show through the transparent humors, like a sparkling red gem, the size of the diameter of the pupil. Such persons can see better in a weak light than in broad day, because the brightness of the sun's light dazzles, and produces a tremulous motion in the whole organ. As an evidence that this redness is caused by the blood in the vessels, after death, when it coagulates, the redness in a great measure disappears. White rabbits, white mice, besides a vast variety of birds, have no pigment on the *choroides*, and are therefore distinguished for red pupils. The existence of the pigmentum nigrum is an evidence of a day-seeing eye. In man, the want of it, constituting the albino, is an anomaly.

A morbid action of the absorbents sometimes removes the paint, and the pupil, to the surprise of observers, becomes scarlet. A partial absorption of it is often the cause of a diminution of the original powers of vision: under such circumstances, the pupil assumes a bronze hue, accompanied by a debility and tremor of the globe under the influence of a moderate degree of light.

MANY ANIMALS SEE IN THE DARK.

Owls, fishes, cats, bats, &c., instead of the pigmentum nigrum, have a silvery paint of a metallic lustre, where others have the black paint, which operates like a concave mirror, in reflecting the light from point to point, within the eye, illuminating it, till its concentration excites the retina to perceive. When viewing a cat's eyes in the remote part of a dark room, there are certain positions in which they are seen by the observer, by the reflected light

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What sort of an eye has an albino, and how does it differ essentially from any other?
Why are the pupils of rabbits' eyes red?
Why can albinos see best in the dark?
How is it that the redness of the pupil disappears after death?
How is the pigment removed?
How is a diminution of the power of vision sometimes explained?
Can some animals see as well in the dark as in the light?
Is the cat's eye phosphorescent, or is the light reflected within, from one surface to another?

within themselves, as though they were phosphorescent: their brilliancy is very peculiar. Upon the principle of a looking-glass behind the retina, all the night-prowling animals are qualified for seeing with those few rays of light which the constitution of their eyes is formed for collecting in the dark. By daylight they perceive objects, as man does in the dark, indistinctly.

Nature is remarkably economical in the use of matter which enters into the composition of animal bodies. If a man be kept a long time in a perfectly dark room, the black pigment is taken away; but a compensation is given him, for he can then see as perfectly in the dark as he could before in the light. On the other hand, the paint is deposited again when he is restored to the light of day. This point has been decided in the persons of state prisoners kept in the dungeons of Europe.

Is there any arrangement in the eye, and what is it, by which animals that see in the dark are enabled to make up for the want of external light? When we consider the metallic lustre of the tapetum, which, in many animals, occupies a great part of the choroid coat, or even its whole surface; farther, its resemblance to a concave mirror, and its relation to the light that penetrates into the interior of the eye, we cannot help considering it as the means employed for this purpose, by its collecting the light, and illuminating, by its reflection, objects lying in the axis of the eye. Prevost objects to this explanation, that there are many animals whose eyes have no tapetum, although they conduct themselves as if they saw in the dark. This is actually the case. The tapetum occurs in carnivora, ruminantia, pachydermata, cetacea, owls, crocodiles, snakes, rays, and sharks: it is wanting in apes, glires, cheiroptera, hedgehogs and moles; in birds, with the exception of owls, and in osseous fishes. But the gnawers or glires, bats, the hedgehog and mole, are animals that obtain their food more by night than during the day; and many of them conduct themselves in the deepest darkness as if they were directed by the sense of sight. But this objection may be obviated, by remarking,

What would be the effect upon the eyes by keeping an individual a long time in a perfectly dark place?

Would such a person, after having been converted into an exclusively night-seeing man, ever be restored again, were he placed within the sphere of the light's influence?

that it is probably some other sense than that of vision, which procures for many of these animals sensations of external objects in the dark. We have, in favor of this opinion, not only the experiments of Spallanzani on bats, from which it appears that, after these creatures were deprived of the use of their eyes, they conducted themselves as if they still possessed the power of vision, but also the examples of species of that family, in which the eyes are so imperfectly developed, or lie so much concealed behind the outer skin, that they are of little or no use to the animal. The genera that see in the dark have undoubtedly so irritable a retina, that they can only see during a very feeble light; whereas, in those animals whose eyes are organized equally for daylight and nocturnal darkness, the retina possesses less irritability. Hence, although these are without a tapetum, it does not follow that this organic part does not afford a mean for seeing during a feeble light.

The tapetum is either spread over the whole choroid, or only over the upper half of it. The first is the case with the cetacea, owls, and with those amphibia and fishes which are provided with this shining envelope; the second occurs in carnivorous and ruminating animals. It is more extended in the ruminating than in the carnivorous tribes; but it always extends so far as to encompass the posterior extremity of the internal ocular axis. All the rays of light from external objects which reach it are united on it, through the transparent part of the eye, and it again reflects back the whole united rays towards the lens. This latter unites them into a single cone, which has the ocular axis as its axis, and its point is directed outwards. The very convergent rays of this cone become more divergent by their passage from the lens into the aqueous fluid, and from this into air or water. Finally, the apex of this cone falls into the point of most distinct vision; for in this point is situated the focus of all the rays that reach from the interior of the eye to the posterior surface of the lens. The cone is complete when the tapetum is spread over the whole of the choroid; but the upper half of it is wanting when it occupies only the upper hemisphere of the coat. The tapetum is confined to the upper half of the choroid in all animals, whose residence and manner of life are of such a nature, that the under half of the retina is immediately

struck by bright daylight, and for this simple reason, because the animal must have been dazzled by the reflection of the bright light from the under half of the latter. It covers the whole posterior portion of the internal eye in the cetacea and owls, many amphibia, rays, and sharks, because these animals live constantly in the water, or in a feebly luminous medium, or have their place of residence in dark corners, or go in quest of food during the night. The experiments and observations of Prevost and Esser, detailed in 1826 and 1827, show that the reflection of light from the tapetum is the cause of the luminousness of the eyes, observed under certain circumstances in the twilight, in cats, dogs, sheep, and in general in all the animals having a tapetum. But whether or not a phosphoric light sometimes proceeds from the retina or choroid, has not as yet been fully ascertained. There are many examples of a luminousness in the dark having been observed in the human eye.

FISHES CANNOT SEE IN AIR AS WELL AS IN WATER.

When the rays of light pass from a rarer to a denser medium, as from air into the aqueous humor of the eye, they are refracted towards the perpendicular. Now the fish has but a drop, as it were, of aqueous humor, and, moreover, the light arrives at its eyes through the whole body of water above. The light is refracted only in a small degree in entering its eye, because the humor is of the same density of the fluid through which the light is transmitted. The cornea is quite flat; if it were prominent, like the human eye, the sphere of vision would be too circumscribed; but by giving a prominence to the whole, and placing the crystalline lens in the fore part of the eye, they have a long diameter, and, with the provision of a large pupil, are completely fitted for seeing in the element in which they were destined to live. With an eye of this description they must necessarily see in air as other animals see in water.

Those animals whose eyes are organized for seeing in water, see but indifferently in air. Hence, in those cases where the habits of the animal require it to see in both

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Why was it necessary, in the plan of aqueous vision, that the cornea of a fish should be flat, instead of convex, like a land-seeing eye? What would the character be of a fish's vision in the air?

elements, it is provided with two sets of eyes, or with eyes accommodated for seeing in both.*

It cannot be denied, that, in general, land animals can see under water, and aquatic animals in air; even man sees under water, although the contrary has been maintained. It is not, however, possible that the same eye is ever so organized as to see equally well in both elements. Land animals always see indifferently in water, and aquatic animals imperfectly in air. The one is long-sighted in water, and the other short-sighted in air. An animal in which the eye is adapted for seeing equally well in air and water, can have but imperfect vision in either. These conclusions are in conformity with what is known of the power of vision in those animals which live partly on the land and partly in the water. The seal lives in both elements; but it has but imperfect vision in the air.

We have the most satisfactory evidence of the short-sightedness of seals, from a series of experiments and observations, made in Boston harbor.

As light loses more of its power in passing through water than in passing through air, and is still more weakened in its progress through the membranes, it follows that, owing to this cause, vision must be less distinct under water than in the air.

MAN CANNOT SEE DISTINCTLY UNDER WATER.

A man under water sees objects as a very aged person sees through a concave glass, placed close to the eye. The fish is long-sighted under water, and man is short-sighted. If he uses spectacles, whose convexity is just equal on both sides to the cornea of his own eye, he will

* A fish peculiar to Surinam, from three to ten inches in length, called *anibleps*, has the front part or cornea of the eye shapen like the two sides of a glass prism: the pupil is therefore divided, horizontally, in the middle. One half is used in the water, and the upper half for seeing in the air. These singular fishes run out of the deep water, into the slimy banks of the river, to hunt for small worms, their principal sustenance. In doing this their bodies are necessarily half out of water. Thus, while searching in the mud with the lower division, with the upper they keep a vigilant look-out for reptiles and rapacious birds, their constant enemies.

Upon what principle does a man see under water?

What sort of glasses could a man use under water, to make objects appear, in relation to color, distance, &c. as they really are?

see under water distinctly. The necessity of this is obvious: the aqueous humor is of the same density with the water, and there cannot, therefore, be any refraction of the rays in passing from the water into the land-seeing eye.

Euclid supposed that vision was occasioned by the emission of rays from the eye to the object. He thought it more natural to suppose that an animate substance gave an emanation than that an inanimate one did. In 1560 the opinion that the rays entered the eye was established. Kepler, in 1600, showed geometrically how the rays were refracted through all the humors, so as to form a distinct picture on the retina; and he also demonstrated the effect of glasses on the eyes.

HOW DOES THE EYE ADAPT ITSELF TO THE DISTANCE OF OBJECTS?

No one has satisfactorily answered this question. One philosopher supposes the eye at rest when we examine a distant object, as a mountain, the spire of a church, or a landscape, but that in the act of seeing near objects there is an effort. It has been supposed that this effort is the action of the *straight muscles*, exhibited in the first plan of the cordage of the eye, compressing the globe so equally as to elongate the eye and lengthen the axis, so much as to favor the union of the pencils of rays on the retina. This could not take place in many aquatic animals, in whose eyes the sclerotica is perfect bone.

Another opinion is, that the eye is at rest in looking at near objects, and laboring when viewing things at a distance. Another is of the opinion that the iris contracts, and so draws the circular margin of the cornea towards the pupil as to make it more or less convex, according to circumstances. A great variety of experiments have been instituted, to determine accurately whether there really is any change made in the length of the axis of the eyeball or not, but none of them can be certainly relied upon. A favorite theory has had its advocates, that the crystalline lens has an inherent power of altering its degree of convexity, and thus accommodates the eye

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Has any one satisfactorily explained how the eye adjusts itself to see both near and distant objects?

to all distances. The truth is, an action takes place in the eye, in adapting itself to near and distant objects, which depends on that vital property of a living system which no theory can reach, and which the deductions of human philosophy can never with certainty explain.

FEELING, OR TOUCH.

Touch is a sensation excited by the contact of bodies, by which we are enabled to appreciate their various qualities, as hard, soft, hot, cold, wet and dry. The immediate seat of this sense is at the point where the nerves terminate in little papillæ, and therefore most perfect at the points of the fingers. This sense is undergoing incessant changes from infancy to age.

That general sense of feeling over all the surface of the body, by which we can designate the forms and other characters of substances brought in contact with the skin, we define to be *perception.*

SMELL.

Perhaps the sense of smell is of the least consequence to man of all his senses: nature designed it and placed it as a safeguard over the stomach, to detect the hurtful from the wholesome food; and in savages it answers this purpose, being always in requisition. In civilized life, however, it is of very little consequence. Its importance to brutes is manifested continually.

TASTE.

This sense resides in the tongue, on which the gustatory nerve terminates, in the form of very small tubercles, beginning at the point and reaching quite into the throat. By it we distinguish certain qualities, as *sweet, sour,*

Define the sense of feeling.
Where is it most perfect?
What is perception?
Is the sense of smell considered very important in civilized life?
Of what importance is it to brutes?
Give your views upon the sense of taste.

bitter, *acrid*, &c. Before the sensation is complete, the substance is necessarily dissolved in the saliva of the mouth, by which means it is uniformly presented to the nervous papillæ.

The sense of taste is believed by physiologists to be very imperfect in the lower orders. As a general remark, fishes feed indifferently on every thing, when pressed by hunger. Anglers have various methods of enticing them to take the hook, but it is obviously through an exquisite sense of smell that they are so speedily brought round the bait. A law exists in Massachusetts forbidding people from taking fish with Indian-berry, so called, which is seized with avidity. They become intoxicated, apparently, in a few minutes, and, floating indolently near the surface, can be taken readily with the hand. The mode of using it is to mix the pulverized berry with bread, in about equal parts, strew it in the water, and wait the result.

Crocodiles, batrachian reptiles, such as frogs, and even serpents, seem to possess no sense of taste. It is quite doubtful whether grain-feeding birds have it, as they as quickly pick up imitation corn as the real. However, each of these has a compensation, and a species of enjoyment arising from the process of digestion, suited to their organization. Both saurians and ophidians, that is, lizards and serpents, after gorging their food, with no mastication in the latter case, become helpless and inactive, and remain so till the contents of the stomach have been taken into the circulation. This peculiar condition after eating, only after long intervals, sometimes of weeks or months, enables other animals to overcome them, and thus the multiplication of these formidable races is limited.

THE GLANDS,

OR ADENOLOGY.

Glands are generally round, fatty bodies, placed at short distances, both internally and externally, whose function is either to secrete a fluid, or change the quality

of that which has been collected by another gland in the neighborhood. Thus, the *salivary glands* about the inside of the cheek, and below the tongue, secrete the saliva of the mouth. The *lachrymal glands* secrete the tears, and the *mucus glands* secrete mucus. Their importance in the animal economy is very great. Tumefactions, or sudden swellings of glands by severe colds, indicate, by the derangement they cause to other organs, their high consequence.

All the different fluids are drawn by appropriate vessels directly from the circulating blood, and conveyed into the various glands. Now we have no means of knowing what modifying influence these organs have upon this fluid. They are drawn from one fountain, yet that which enters the salivary glands, in the region of the mouth, becomes saliva, an indispensable diluent for the food. Another portion, on being conducted to the lachrymal gland in the orbit, is converted into something altogether different in character from saliva, and only suitable for moistening the eye. And so it is with them all—each elaborating from what may have been carried to it, from the great fountain, a fluid chemically peculiar, and of the utmost importance in the economy of the system.

INTERNAL ORGANS, OR SPLANCHNOLOGY.

Under this division is embraced the viscera or contents of the three great cavities, viz., in the head, chest, and abdomen. Of the contents of the skull we have already treated.

VISCERA OF THE THORAX.

Within the thorax or chest, which is bounded by the neck above and the diaphragm or midriff below, are contained the following organs, viz: the *pleura*, *lungs*, *heart*, *thymus gland*, *œsophagus*, *thoracic duct*, *arch of the aorta*, *branches of the cava*, *vena azygos*, *eight pairs of nerves*, *and part of the sympathetic nerve.*

PLEURA.

Two membranous sacs are lodged in the chest, one on either side, attached closely to the ribs, but their sides, meeting in the middle, under the breast bone, unite and

form a partition, called *mediastinum.* Thus the chest is lined, so that each lung has an independent apartment.

The heart, inclosed in its case, lies in a triangular space between the two lungs.

DIAPHRAGM.

This is nearly a horizontal partition between the chest and abdomen, and is perfectly muscular. Its border adheres to the ribs, breast bone, and spine. Through it, near the spine, are openings for the passage of the swallow, blood-vessels, and nerves.

The diaphragm is a muscle of respiration, rising upward as the lungs collapse, and falling down again as the lungs become inflated.

This fleshy partition, which separates the body into upper and lower regions, is a very curious piece of mechanism, usually called the midriff. It is, in fact, a great muscle of respiration. It receives nerves high up in the neck, quite above the shoulders, for the purpose, as it were, of placing it beyond the sympathetic influence of the immense collection of nerves within the chest and abdomen. If the spine be injured below the origin of these cervico-diaphragmatic nerves, respiration is not destroyed. Repeated cases are on record of persons who had so entirely lost the sense of feeling in the lower part of the body and extremities, in consequence of having the spine injured by falls, &c. that no difference could be felt between heat or cold; and yet, owing to this beautiful contrivance of having the nerves take their origin in the neck, such unfortunate, almost totally helpless beings, in the full possession of their intellectual powers, with a vital apparatus unimpaired, though one half the body was dead, as regarded sensation, have lived to the full term of three-score and ten. Birds have no diaphragm, their thorax and abdomen being one common cavity.

LUNGS.

These are two membranous organs, by which breathing is effected. The physiology of the function of the lungs has been considered in detail with the circulation of the blood. They are divided into *right* and *left:* the right lung has three *lobes*, but the left only two. They seem

to be made up of a spongy substance, air tubes, and blood-vessels. Their use cannot be misapprehended.

By *respiration*, is meant the ingress of air into the lungs, and by *expiration*, its egress from them.

Voluntary respiration depends upon the will, when we are awake, but *spontaneous* is the respiration of sleep. It is thought that the exciting cause of the process is the irritation of the nerves in the air cells, which, by a consent of parts, gains the assistance of the diaphragm and intercostal muscles and ribs to expel it. The object of respiration is the oxygenation of the blood. Though the vital temperature of the body cannot be readily accounted for, it is generally admitted that heat is developed by the action of the atmospheric air on the volume of blood exposed to its influence within the air cells.

As an introduction to a description of the vocal apparatus of man and other animals, it seems necessary, first, to explain both the process of breathing and its necessity in the animal economy: because, in the sequel, it will be apparent, that without lungs there could be no voice.

Such is the constitution of every living creature, that a free use of atmospheric air is absolutely necessary for sustaining life. The mere circumstance of being surrounded by air is not sufficient: if it were, there would be various ingenious devices for maintaining life, after the lungs were rendered useless by disease or accident.

It is absolutely necessary that air should be taken into the system, and brought in contact with the moving blood. The various modes by which nature has accomplished this, in the mechanism of some animals, will now be considered.

If Spallanzani and some others are to be credited, in their accounts of what they discovered by the microscope, we have the first plan of a breathing structure. Spallanzani pretended he saw the respiration of animalcules in vinegar. They were shapen like stars, and in the centre of each were two dark globular spots, one of which he conceived to be the heart pulsating, and the other the lungs. Every two or three seconds, to use his own

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What is meant by respiration?
Are there two kinds of respiration?
Is any change effected on the quality of the blood by respiration?
How is vital heat maintained?
Could any animal exist without air?

words, they were slowly blown up three or four times their natural size, and then slowly compressed again. A modern physiologist remarks, that the Abbe must have forgotten himself in assigning them lungs, for they were evidently aquatic animals, and therefore did not require them.

Passing by the microscope, let us examine something more tangible,—the families of insects. They are so organized that, in proportion to their bulk, they require a prodigious supply of air. The heart is the only perceptible organ in flies and worms: how their breathing organs are constructed we are totally ignorant.

Pertaining to that apparatus, the existence of which cannot be questioned, is an immense number of air tubes, coursing over and through every part of them, distinguishable with the naked eye, resembling white lines. It is necessary that these be always distended. They open generally with free mouths, on the sides of the body, and wherever there is a ring or line it marks the place of one of them.

In worms it also appears necessary that the air holes or *spiracula* be perfectly free and open. The moment a little varnish is applied, ever so delicately, to the last holes, that portion towards the tail is paralyzed. By closing the next two, another ring is palsied; if all but the two last, towards the head, are closed, it still lives, though it cannot move; but when the last of the series are closed, it dies immediately.

Some vermin require more air, judging from analogy, than others much superior in size. So variously are the tubes ramified, that the viscera appears to occupy only about one fifth of the whole internal cavity.

Before insects arrive to their perfect state of existence, they are destined to undergo several interesting changes. First they are worms, ordinarily of a loathsome and disgustful appearance; and lastly, a beautiful winged insect, the object of peculiar admiration. In this change there is nothing discoverable to the philosopher like the death and resurrection of the insect, so often the theme of writers. It does not die while undergoing the change;

How do insects breathe? What are their breathing holes technically called?
Have worms a similar apparatus?

if it did, the process would never be perfected: close the spiracula and there is forever an end to its existence.

While the caterpillar crawls on its numerous feet, under its coarse, hairy skin, it has six legs, inimitably folded next the body; two pairs of wings, that only require the sun's rays to astonish us with the beauty of their coloring; and a proboscis, nicely packed away, to sip the honey which will be its future food. The period finally arrives when a development of these embryo organs is about to take place. Some inscrutable sensation, of which the worm appears to have an instinctive knowledge, as it seeks a quiet, safe, and warm retreat, gives it a timely warning. The old covering becomes dry and dark; the fluids cease to circulate in it, and gradually, as the legs and wings gain freedom within, they push it entirely off; thus disentangled, it flits away on its untried wings, from flower to flower.

While the skin was drying, the worm breathed, as it did before, through the air holes of the old covering.

Insects, it is supposed, never breathe by the mouth. The nymphæ of gnats can raise themselves to the surface of a pool, and breathe by an orifice in their backs. The *hydrocanthiri* breathe by thrusting their tails out of water. Bugs, flies, and worms, which live in filth, ditches, and deep under ground, breathe the pure air which is in their air tubes, and when it is exhausted they travel near enough to the surface to replenish their stock. But the maggot of the *eruca labra* has the most extraordinary apparatus imaginable. It shoots from its tail a tube, resembling the slides of a spy-glass, one beyond another. The last has a star-like tuft on the end, which, unfolding on the water, enables it, thus buoyed up, to breathe freely, while it floats about at pleasure, in search of food.

Fishes are without lungs, and yet they require a constant supply of air, though in a lesser quantity than animals with a double heart. Such is their peculiarity of structure that they breathe a mixture of air and water together. The gills enable them to perform this process. Deprive water of its air, and the fish dies as soon as it

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While undergoing their metamorphoses, do they continue to breathe?
Have fishes lungs?
What organs do fishes possess analogous in function to lungs?
Could they live in water deprived of atmospheric air?

would out of water. The free exposure of the gills to water is not sufficient: it is necessary to propel the water through them forcibly. If the feathery gills of a small perch could be unfolded and spread, it is not improbable that they would cover a square yard. This will not appear so extraordinary when it is recollected that the nerve in a dog's nose is spread into so thin a web, that it is computed to be equal to four square feet. Observe the wonderful economy of nature; this web is so rolled up, like a scroll of parchment, that it could be packed away in a thimble.

Nearly one third of all the blood is exposed to the action of the air, in the gills, at the same time. The fish draws in a mouthful of water, and with a quick motion, by closing the jaws, drives it through the gills, and this imparts vitality, and restores the red color to the dark blood of the veins.

Various tribes of fishes which seek their food in the mud, and fœtid, turbid water, have a striking provision for defending their gills; otherwise they would become clogged, and breathing would be interrupted by the very filth in which they were actually created to live. Their gills are small, and covered by the common skin of the body. The water is taken at the mouth, and driven with the same force as in the other case, but emptied through holes on each side of the neck, just back of the jaws. The force is always sufficient, by dividing the water into distinct portions, to keep the openings completely clear. In fact, the action is like that of an apothecary's syringe. A familiar example of this sort of animal mechanism may be seen in the lamprey eel.

A similar breathing apparatus is provided for shell fishes, having, however, an additional contrivance, by which they can live a considerable time out of water. Here let the mechanism be particularly noticed, and admired too, as the first step towards a terrestrial animal. As those inhabiting salt water are necessarily exposed, by the receding of tides, without a limb to assist them in regaining their home, and so organized with extensive

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Is breathing a voluntary or involuntary process with them?
Explain the principle of their respiration.
Are all fishes organized alike, in respect to this function?
Is there any thing remarkable in the structure of the breathing apparatus of shell fishes?

gills, encircling two thirds of the circumference of the shell, that they cannot breathe air, their apparently helpless condition has been provided for in this interesting manner, viz: they are furnished with a long elastic pipe, which is a reservoir for water. At necessary intervals the fish ejects a drop, with surprising force, through the fringes of the gills, and then remains quiet, till some instinctive sensation warns it of the necessity of again working its forcing pump. Being cold-blooded, that is, having the single heart, one throw of the brake suffices for a long time.

In travelling over a clam bed, at low tide, the tremor communicated to the fish apprizes it of approaching danger; and the nearer the observer advances, the more distinctly can he witness the amazing projectile force with which the clam drives a little column of water up through the sand.

Fig. 97.

Explanation of Fig. 97.

This drawing represents the gills and water tube of the oyster, which differ but very little from the respiratory apparatus of common salt water clams. *a*, is the orifice of the tube referred to in the remarks above, into which a needle is introduced; *c*, the region of the digestive organs; *b* and *d*, the extensive border of gills or lungs.

This is only part of the contents of the tube. Nothing but continued irritation will induce the clam to part with the remainder,—which is noticed, in digging, just as the shell is exposed to the light.

By this reserved fund, it can live many days in open air. It is by this tube of water that the oyster is kept alive in the shops. As the exposure in the open air weakens its system, it recruits itself by jetting a drop of water through its gills. This drop may be seen morning after morning, on a dry board. But when the reservoir is wholly exhausted, it opens its shell, fearless of conse-

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If so, describe the mechanical process.

quences, and seeks in despair, wherever it can reach, a fountain, to replenish its engine. Thus it languishes, and at last dies a protracted death, in search of its accustomed element.

No class of animals is more wonderful, on the other hand, than the amphibious. They live alternately in two elements, hearing and seeing tolerably well in both. The structure of some of their organs of sense has already been considered. But it is not true, as too generally believed, that they alternately respire air and water, or a mixture of both. They are cold-blooded animals, it is true, with a single heart; as, for example, the frog and aquatic lizards. The water seems to be their peculiar element, but, after all, they breathe the air exclusively. They constitutionally require only a small quantity of oxygen, or vital air, to sustain life, and keep the machinery in operation. They have lungs, but they have but a faint resemblance to those having warm blood and a double heart.

Their lungs are merely membranous bags or cylinders, which, in their dry, prepared state, appear like bubbles of froth. The next extraordinary circumstance is this—that breathing is an act depending on the will; that is, they can breathe regularly, at short intervals, for days together, or they can stop the respiratory process for hours, or perhaps days, and continue equally vigorous.

Fishes, we have seen, force the water through their gills: the same process of forcing air into these membranous tubes is accomplished, in amphibious animals, by a very little additional mechanism—the mouth acts precisely like a bellows. The jaws are grooved above and below, that they may be air-tight, and a slit, acting like a valve, is placed at the root of the tongue, over the wind-pipe, leading to the lungs. The mouth is never opened except for food. The air is drawn in through very small nostrils, which in the frog and neut are not larger than cambric needles. The animal slowly draws its mouth full of air, and, when sufficiently distended, forces it through

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Do amphibious animals, so called, breathe alternately or indifferently air or water?

Why are not lizards, and other reptiles possessing a single heart, under the same necessity for uninterrupted respiration?

Is this breathing an act of volition?

Why are the jaws fitted so closely together in frogs?

the valve, by the skin, which looks like a pouch under the lower jaw.

The lungs, being full, give additional size to the body. The abdominal muscles re-act, and slowly press it out again; and thus we have an example of the mode by which this class of animals breathe.

If the frog's mouth be kept open with a prop, it will inevitably die, as there is no power by which it can inhale air, short of the bellows of its jaws. It requires no philosophy, after becoming acquainted with these interesting facts, to account for their large mouths and broad jaws. No other shape or structure would so completely constitute the bellows.

Fig. 98.

Explanation of Fig. 98.

On either side of *c* are the nostrils of the frog and toad, indicated by dots; *a* is the border of the pharynx, the funnel of the food pipe, out of which the tongue seems to protrude; *b* is near a slit in the base of that organ, leading to the lungs, through which the atmospheric air is forced down into the lungs; *d* is the point of the tongue, which is represented to be in a flaccid condition. When this reptile is taking flies, its principal food, the tongue assumes the appearance of a small, round wire, of a deep red color. It is darted with such rapidity that the impression made on the eye of an observer is like that of a flash of light. All the smaller class of saurians, or lizards, feed in a similar manner. At the extremity of the chameleon's tongue there is a kind of cup, which opens to receive the insect, where it is secured in a twinkling, in the instant of darting it out some six or eight inches.

Neuts', lizards' and the chameleon's lungs are cylinders, running down the sides of their bodies, the whole length; and as they force in the air precisely by the same

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Cannot they breathe by the mouth?

process, it will explain the reason of their appearing fat at one time, or thin and lank at another. When irritated, or in fear, they blow up their bodies to frightful dimensions, to appear more formidable, upon the same instinctive principle that cats, dogs, hedgehogs and fowls bristle up their covering at the approach of an enemy superior to them in strength.*

The different colors with which the chameleon so readily dresses itself, depend on this peculiarity of its lungs. The skin is covered with an exquisitely fine covering, like velvet. If the lungs be filled to a certain extent, the swelling of the body erects the fleece, so that the manner in which the light strikes it makes the animal appear green, white, or of other colors: another blast into the lungs gives another inclination to the fleece, and it has another tint. When, by irritation, its body is blown up to its greatest dimensions, various modifications of these colors are exhibited.

From this tribe of reptiles the first advance is made towards endowing animals with the power of producing vocal sounds. The water is only capable of propagating a vibration, but that with great certainty and strength, and nature has constructed an ear suited to the element and the habits of all aquatic beings. To have bestowed an

* Crocodiles and alligators are provided with these very small, delicately organized membranous lungs, notwithstanding their prodigious muscular power. All reptiles are tenacious of life to a wonderful degree. In tropical regions, during the rainy seasons, and in those parts of the world where there is a winter, they remain in a perfectly torpid state, called sleep, till the return of the sun's genial rays. This is a most admirable provision for preserving them, when their proper food cannot be had. They require so little oxygen that the lamp of life is just kept burning for months together, and the little fat they have accumulated serves to keep the digestive organs barely moving the whole time. If they are awaken from this state by an artificial temperature, a voracious appetite is immediately manifested; but the stomach refuses to resume its natural function, and they die in a little time. The author, a few years since, exhibited an alligator before a large audience at the Temple, in the course of a lecture on vitality, with reference to explaining the condition of these animals in a torpid state, which was handled freely and with perfect safety, till the heat of two anthricite stoves, each side of the raised platform, unexpectedly roused him, to the surprise and terror of the speaker. The instant his eyes were opened, it was necessary to secure him in the envelopes of a baize table-cloth. After the close of the lecture, a piece of meat was given him, at the menagerie, which he seized with voracious avidity, but expired with it between his horrible teeth.

How is it that some reptiles are enabled to increase or diminish their size, almost instantly?
Is sound propagated in water?

ear susceptible of receiving the modification of sound, would have been superfluous, inasmuch as the modifications are alone effected in the vocal box of those breathing air.

The atmosphere is the medium of modified sound: it is an elastic medium, which can be put in motion by the vibration of solid bodies. It is a medium which, when set in motion by a mechanical contrivance of the greatest apparent simplicity, transmits the wants of animals, in what is denominated a natural cry; and in man expresses not only his wants, his pleasures, and his pains, but all his thoughts,—because his voice represents ideas. Language, therefore, is the symbol of thought.

The voice of all animals remains the same through endless generations, unless the vocal apparatus is artificially altered. Indeed, the vocal organs are so constituted that they admit of little variety in their movements: every succeeding class, however, exhibits an additional muscle, a bone, or some difference in the shape of the tongue, giving it the power of either making one more sound than the race below, or some modulation of the original tone. Were it not for this progression in the contrivance, the voice of all animals would be precisely the same, like sounding one note continually on a musical instrument.

Let us examine another curious mode of respiration, peculiar to birds. Although there is an external resemblance, in the shape of their bones, to quadrupeds, and the muscles which move them are similarly arranged, to effect a circle of motions, their structure has reference to their wafting themselves through the air.

In the first place, the long bones are without marrow, being hollow tubes, filled with air; these actually have openings communicating with the lungs. At their further extremities they permit the air to circulate into the ends of each feather; and, lastly, the body has large apartments exclusively appropriated for the reception of the same air. Their lungs, unlike the light, frothy tube of reptiles, are spongy and gorged with blood, and totally unlike those belonging to any other animal. In the bird,

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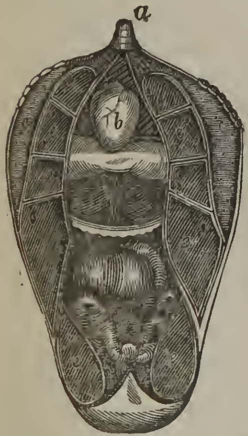
Are the lungs of birds different in structure from other animals?

Why is the air allowed to pass entirely through these organs, in birds?

the lungs are open at each end, and are so closely tied down to the back bone and ribs that they admit of little or no distension or contraction.

Their breathing is effected in the following manner: viz. the air is drawn into the vacuum caused by the pressure of the strong muscles of the abdomen; in other words, the weight of the atmosphere forces it in, so that the current rushes through the whole length of the lungs, where the blood is waiting for its appearance, and passes to the extremities of all the bones and feathers. The proper change being wrought in the venous blood, it is circulated again to the heart; while the muscles again empty the lungs and air cells, contiguous, by a general compression of the whole. Here is discoverable the mechanism for producing voice, seen in its elements in the frog, improved upon by additional cords and vibrating

Fig. 99.



Explanation of Fig. 99.

A horizontal section of the body of an ostrich; *a* is the wind-pipe; *b* the heart, located and surrounded by air, in a cell, the apex resting on an hour-glass-shapen cylinder, also filled with it; *c c*, the lungs; and *e e e e*, large air chests. These exist in a miniature form in most of the birds. It is by the boxing up of so much air in these numerous apartments that the ostrich is enabled to run with such extreme swiftness. As the body becomes heated by exercise, the air becomes also rarefied, and the longer it runs, the lighter and more bounding it is in its step. Its speed far exceeds the horse; and this mammoth bird will sometimes continue at the top of its speed thirty hours in succession, without resting, when hunted on the borders of its native deserts.

The reason why wild fowls are able to rise so quickly on the wing is because the canals are large, by which the air rushes through the body in the act of expanding the wings, which is in effect like opening a valve. Domestic fowls, from disuse of this apparatus, have the air pipes but partially developed; hence they are obliged, ordinarily, to run and flap the wings, to force in a volume of air, before the body is specifically lighter; the moment this is effected, they can rise. The movements of the common goose, when driven, fully illustrates the operation.

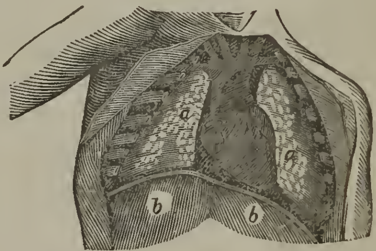
Explain the peculiarity of the respiratory organization of birds.
How is the air which has imparted vitality to the blood by being drawn through the lungs, conducted out of the body again?

cartilages, susceptible of receiving a current of air, in a manner a little different, to produce one, two or three different tones.

Lastly, nature has effected respiration by a more complex piece of mechanism in those animals whose bodies are divided into two apartments by a diaphragm.

A difference of structure does not appear in the air cells of the lungs of about forty varieties of animals, including man. The only circumstances observable, relate to their shape and subdivisions, depending on the configuration of the cavity in which they are lodged. The human lungs are suspended in the chest, much as they are in brutes, by the wind-pipe, and so tied down at the upper part of the neck, and so carefully fitted to the dimensions of the box in which they are lodged, that no position of the body can throw them out of place. There is a right and a left lung, perfectly independent of each other, and separated by a middle partition.*

Fig. 100.



Explanation of Fig. 100.

This diagram explains the relations of the vital organs of man. The breast bone and the anterior portions of the ribs being removed, shows the exact positions of the right and left lungs, marked *a a*. The heart, suspended by its vessels, is between them. *b b*, the right and left divisions of the diaphragm, which rise and fall at each inspiration and expiration, synchonously with the lungs.

* One lung may be badly diseased, and the other remain perfectly unimpaired, many years. A case is recollected in which the left lung was entirely destroyed by ulceration. The cavity, however was filled with a

Are the human lungs similar in structure to those we have been considering?

How are they connected with the cavity in which they are placed?

Can they be thrown out of place by changing the position of the body?

Exactly in the centre of this partition, in quadrupeds, the heart lies, but in man it is on the left side, and therefore projects into the cavity of the left lung. They are made up of millions of air cells, which are filled at every inspiration. The blood, directly from the heart, is thrown into them in prodigious quantities, and circulates so minutely that each air cell is completely surrounded by a sheet of dark blood.

VOICE.

We shall now inspect the contrivance by which sounds are produced by animals.

By voice, animals have the power of making themselves understood to their own species; and these sounds are either *articulate* or *inarticulate.*

Language is an acquired power, having its origin in the wants of more than one individual. Man, without society, would only utter a natural cry, which sound would express nothing but pain.

Supposing a human being to have been entirely forsaken by those of his species, in that stage of infancy when he could have no recollection of any thing pertaining to his race, his voice would, in essence, remain the cry of an infant, only strengthened in tone, at a particular age, by the development of the vocal organs to their destined size.

But let two individuals be placed together, but without communication or knowledge of the existence of beings similar to themselves, the natural cry of each would undergo modifications: the one would make a sound, to express a particular sensation, which in time would be

vast quantity of purilent fluid matter which pressed the heart from its natural position, so that its apex could be felt pulsating on the right side of the chest.

A captain of the United States Navy died several years ago, at sea, in consequence of being wounded in the chest by a duellist. Though the ball passed entirely through the body, and the wound healed on one side, a constant discharge was kept up from the other. After death, it was ascertained that the lung was entirely destroyed; and lying upon the diaphragm was an oiled patch, with which the bullet had been covered. Nature was exerting herself to wash away the offending irritant through the opening, but the powers of the system were exhausted before she had accomplished her plan for saving his life.

How is the heart lodged, with respect to the lungs, in man?

What is voice?

How are sounds divided?

understood by the other: a repetition of the same note would be the sign of that sensation in future.

An additional sensation, having an intimate connexion with the first, would require a variation of tone; and this would also become a symbol of two sensations. Here, then, would be the origin of language. Multiply the species, and each new member of the society would express some other sensation or want, by another modification of the original cry. Here we discover the certain commencement of a spoken language. These different sounds, becoming classified, constitute a dictionary, in which each word is the mark or sign of particular sounds; thus, if an individual can imitȧte the sound, or a series of sounds, he masters a language. Let it be remembered that man could never arrive to this perfection in sound or language if his vocal organs were not differently constructed from brutes. Such is the mechanism of theirs, that so many sounds, and no more, can be made; but in man's organs there is no limitation—no sound appreciable that he cannot imitate.*

THE VOCAL BOX, OR LARYNX.

Directly under the integuments on the front side of the neck is a cartilaginous tube, the *trachea*, or wind-pipe, built up of a series of narrow strips, which are portions of a ring; therefore it is always kept free and open. At its lower end it divides into two branches, going to the lungs on either side, but its upper portion is enlarged, just under the chin, and finally opens in common with the tube of the stomach and mouth. This enlarged part, quite prominent in man, is the *larynx*, or vocal organ.

* It is not uncommon to be asked why monkeys, ourang outangs, &c. cannot talk. In the first place, they have nothing to say. It is hardly possible to discover any very striking anatomical difference in the structure of their vocal organs from our own. The essential difficulty, therefore, is in the brain; had they the cerebral organization of man, they would have sentiments, and the possession of the intellectual faculties, as a law of nature, would be accompanied with a corresponding power of explaining their ideas by articulate language.

The larynx of the whale very much resembles the vocal box of some quadrupeds. The whale, it may be recollected, has lungs, and breathes air, and consequently, in its internal structure, is not a fish.

Where and what is the trachea? How is it formed? What is the larynx?

Several cartilages assist in its formation, viz. the *thyroid*, *cricoid*, the *arytænoid*, and the *epiglottis*. The cricoid is the foundation; the thyroid is the wall around it; the arytænoid are appendages to the back of the cricoid; and the *epiglottis* is a valve, opening and closing the entrance into the wind-pipe, like the valve of a bellows.

Fig. 101.

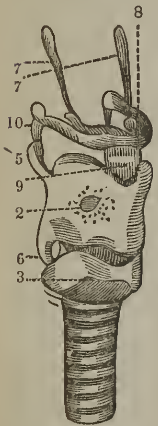
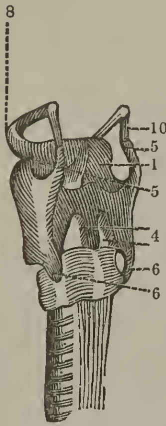


Fig. 102.



Explanation of Figs. 101 and 102.

The five cartilages are,
1, The epiglottis.
2, The thyroid cartilage.
3, The cricoid auxiliary, and,
4, The two arytænoid cartilages.
5, The two superior horns of the thyroid cartilage.
6, The two inferior horns.
7, The suspensory ligament of the os hyoides.
8, The os hyoides.
9, The azygos ligament, connecting the os hyoides to the thyroid cartilage.
10, The two lateral ligaments connecting the horns of the os hyoides to the superior horns of the thyroid cartilage.

One of these diagrams presents a front and the other a back view of the *larynx*, or vocal box. The bone of the tongue is seen, like half of a hoop, marked 8, in both plans. 2 is the front of the *thyroid cartilage*, felt under the skin, protruding in the form of an irregular tumor. The wind-pipe is the tube at the bottom of each larynx. The *vocal cords*, the membranes which vibrate to produce sound, as the current of air rushes by, are concealed, being placed inside. From the remarks in the text, together with the references, a very correct idea will be formed of the structure of this curious organ. By blowing through the wind-pipe of almost any animal, soon after it is slain, provided the larynx has not been injured, the vocal cords may be put in motion, and the sound which is produced will bear considerable analogy to the natural voice of the animal.

Within the larynx, and consequently below the valve, are four delicate membranes, two on each side, put upon the stretch,—being, in fact, like shelves,—their thin edges nearly meeting from the opposite sides, so that

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How many cartilages is it composed of? What is the epiglottis?

there is scarcely any space between them. These are the vocal cords.

When the air rushes out from the lungs through the wind-pipe, it must obviously pass through the larynx; in doing which it strikes the tense edges of the cords, and produces a vibration. This vibratory motion given to the current of air produces sound. In the cavities of the bones of the face, forehead, and nose, its power is increased, and in the mouth it undergoes further modifications, and ultimately becomes articulate language. The teeth, tongue, lips, nose and fauces have each an influence in the production of articulate sounds. Hence grammarians have arranged the human voice under the appropriate divisions of *guttural*, *nasal*, *dental*, and *labial* sounds, expressive of the agency which each of these organs exerts on the original tone.

Shrillness or roughness of voice depends on the diameter of the larynx,—its elasticity, lubricity, and the force with which the expired air is propelled through the *rima glottidis*, or slit-like chink between the vocal cords.

Because the larynx is smaller in women, and more elastic, their voice is of a different character. The breaking of the voice, *vox rauca*, noticeable in boys at a particular age, depends partly on the enlargement of the apartments within the bones, which generally takes place at the important crisis of their lives when the whole constitution undergoes a sudden change.

But the mechanism of voice would have been incomplete, were there not a number of exceedingly delicate muscles, which graduate the diameter of the narrow slit through which the sound escapes into the mouth. Unconsciously, they effect the requisite contractions, forever varying, according to the rapidity, intensity, or strength of the voice, in singing, conversation, or declamation.

Finally, the larynx is a musical wind instrument, of the *reeded* kind, on the principle of the hautboy. The nearness of the vocal cords to each other resembles that instrument

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Where are the vocal cords?
How is sound produced in the larynx?
How is the strength of the voice increased?
How is the voice modulated?
How are sounds classified by grammarians?
On what does the shrillness of the voice depend?
Of what service are the muscles about the neck, in relation to voice?
Is the larynx a musical instrument in effect?

precisely. All the tones of reed instruments are effected by finger-holes, but the tones of the human voice are varied by the extrinsic and intrinsic muscles, which shorten or elongate the vocal tube. Thus the same result is produced by this process—increasing or diminishing the diameter of the larynx—that is accomplished in the clarionet, bassoon, flute, and hautboy by a graduated scale of finger-holes.

Is not this another beautiful mechanical evidence of the existence of a Being superior to ourselves?

VENTRILOQUISM.

At a period not very remote, physiologists entertained an opinion that persons possessing the ventriloquial power of imitating the voices of men and animals, were peculiar in their vocal organization; it has been satisfactorily ascertained, however, that such is not the fact. Almost any one may acquire the tact of speaking in a tone widely different from that which is familiarly denominated his own. By continual practice, the individual soon discovers the possibility of articulating words with a very limited motion of the lips. Those, therefore, who become expert in vocal imitations, appear to be perfectly silent. Nasal sounds are most easily produced; but the labials, to a certain extent, are very well conducted by the soft palate, or faucal arch, at the top of the throat. With regard to the supposed innate ability of professed performers to throw the voice wherever they choose, it is an entire deception: they contrive, by various modes, rarely suspected at the time, to divert or distract the attention of by-standers, so ingeniously, that the point from whence the voice appears to issue is entirely a deception of the imagination.

I once heard a gentleman lecture in Boston upon the subject of acoustics, and, in illustration of some principle, he took up a flute and assumed the attitude of one playing. The application of the lips to the blowing hole, the natural movement of his fingers, together with the accompaniment of a plaintive air, impressed the audience with

the truth of his proposition. When, in the course of twenty minutes after, he told them that he had not sounded a single note on the instrument, and that he could not play a tune, and, moreover, assured them that it was a successful deception he had practised upon their eyes and ears, the most perfect of our organs of senses, they expressed their utter astonishment. The air was played by a man, behind a curtain, in one corner of the hall. This explains sufficiently well the ease with which we may be deceived under circumstances of an excited imagination, and also demonstrates the little reliance to be placed on the senses of hearing and seeing when an attempt is made, by a skilful deceiver, to influence the judgment through their instrumentality.

To imitate the songs of birds, the guttural variations of the mocking-bird, the chirp of squirrels, the hum of the bee, &c., a small, oval, metallic frame is held between the teeth. The outer edge is grooved, that the teeth may keep it firmly in the line of the current of air blown through it. Edgeway, stretched from the longest diameter of this, is a narrow silk ribbon, which vibrates very delicately. The slightest variation of the labial orifice produces a corresponding alteration of tone; and in this way a vast variety of appreciable sounds are imitated. The instrument is so small that it may be thrust aside by the tongue instantly, or replaced at pleasure.

Occasionally, boys succeed in imitating the sound produced by letting off a current of steam. There is one in Boston whose imitation is so perfect, that, were he to exert himself, a whole multitude would be alike impressed with the idea of the rapid approach of a locomotive engine.

Alexander Paris, Esq. informed the writer that he saw a slave in Virginia, who was so perfect in ventriloquial exhibitions, that he imitated the compound music of a very distant drum and fife.

In the midst of a very great collection of people on Boston Common, who were collected on the evening of the 4th of July, the present season, a country lad so painfully imitated the cryings and moanings of a distressed infant, somewhere under foot, that every one involuntarily looked with deep anxiety for the little sufferer.

Another class of vetriloquial imitations consists in suddenly withdrawing the finger from the mouth when

in the act of compressing a volume of air. Thus, the sounds like those of drawing a cork from a bottle, sawing wood, throwing heavy blocks of wood upon the floor, &c., are made, and reproduced, with rapidity.

Ventriloquism, therefore, instead of being a peculiar property of a few individuals, of different countries, is an imitative art, which may be acquired by almost any person, with a moderate degree of practice.

THE VISCERA,

OR SPLANCHNOLOGY.

THE FOOD-PIPE, OR ŒSOPHAGUS.

This is a fleshy tube, going from the back of the mouth to the stomach, through the chest, lying in the neck behind the wind-pipe. Its upper portion is called the *pharynx*, or fauces, and its lower, the *cardiac* extremity, terminating in the stomach.

The common opening or coalescing of the wind-pipe and œsophagus constitute the *pharynx*. By looking into the back part of the throat, an arch is noticed, of a singular construction. In reality, there are two of them, united at the top, but receding from each other at the base. In the intermediate space between the legs of these arches, on either side, the amydaloid glands are placed, usually called almonds of the ears. As a morsel is rolled, by the retraction of the tongue, through this gateway, the upper pendulous, fleshy knob in the centre, *uvula*, falls down, like a port-cullis, and thus secures the food. In passing through the space intervening between the arches, it presses against the amydaloid glands, which pour out a

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What is splanchnology?
Describe the œsophagus.
What is its relation to the trachea or wind-pipe?
Where is the cardiac termination?
What is the pharynx?
What prevents food from falling into the lungs?
Where are the faucel arches?
What is the office of the amydaloid glands?

fluid to moisten it, that there may be no friction in its progress down the œsophagus into the stomach. When this act is complete, the front arch re-opens, involuntarily, to be in readiness for another portion.

By the closing down of the epiglottis, (an elastic valve, lying directly over the opening of the larynx,) the food slides over and falls into the appropriate tube. When, accidentally, the valve gets partially propped open, in the act of swallowing, so that the smallest possible quantity of either a solid or a fluid gets into the vocal box, a convulsive cough instantly ensues, and continues, generally, till the foreign matter is forced from its wrong lodgment.

The *uvula*, or central fleshy pap, is occasionally exceedingly elongated, owing to the loss of tone in its muscular tissue. Under such circumstances, it reaches low down into the faucal region, and, by constant irritation, produces a severe cough, which, if not relieved by the excision of the uvula, in case astringent gargles fail to make it retract, ultimately causes an extensive inflammation of the lining membrane of the lungs. Thus, by a sympathetic action, a pulmonary consumption may be induced.

THYMUS GLAND.

Infants and young children possess a singular gland, located just behind the top of the breast bone, which has the appellation of *thymus gland*. In adults it is obliterated; hence it is supposed to be serviceable only in the early stages of our existence.

THORACIC DUCT.

Quite low in the abdomen is found a white, exquisitely delicate tube, which runs upward by the side of the spine, and finally terminates, by communicating with a large vein in the angle between the neck and shoulder, on the left side. All the nutritious substance which has been collected from the food in the intestinal tube,—now called *chyle*, which is white like milk,—is conducted to this

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Why is a convulsive cough produced when food falls into the larynx?
What is said of the thymus gland?
Where is the thoracic duct, and what is its office?
What is chyle?

thoracic duct, and thence carried on to be poured directly into the circulation, to become blood.

ABDOMEN.

Bounded by the diaphragm above, the pelvic bones below, and the muscles at the sides, the abdomen is the most capacious of all the cavities. Its lining membrane is the *peritonæum*. Various organs, principally subservient to digestion, are contained within it. They are the following.

OMENTUM.

Vulgarly, the *omentum* is the caul, a sort of apron lying in front of the intestines, suspended mainly from the stomach.*

LIVER.

Being the largest and heaviest viscus in the body, the liver has also a vast influence on the condition of the whole. It is divided into right and left lobes. The right is the largest, and occupies the right side, under the ribs. The left lobe lies partly over the stomach, in the other region. Its use is to secrete bile.†

GALL BLADDER.

This is attached to the under side of the liver, shaped like a shot-pouch, and contains between one and two

* It is generally supposed that the sudden twinging pain, known as *a stick in the side*, is caused in consequence of the omentum being pinched by the vermicular motion of the intestines.

† At birth, the liver fills considerably more than half of the abdominal cavity; but soon after, it appears to diminish in size.

This important viscus, in a state of disease, is extremely painful. Drinkers of spirituous liquors are fatally predisposed to a derangement of its functions.

Poultrymen, in some parts of Europe, have discovered a method of producing an enormous schirrous enlargement of this bile-secreting organ in geese, ducks and turkies, which is esteemed by gourmands to be a delicate dish, unsurpassed by any thing else in modern cookery.

Where are the contents of the duct conducted into the circulation?
Does the chyle become blood?
What are the abdominal boundaries?
What is the lining membrane of this cavity called?
Describe the omentum.
Where is the liver placed, and what are its peculiar functions?
With what organ is the gall-bladder connected?

Fig. 103.

Explanation of Fig. 103.

In this view of the abdomen, *d* is the gall-bladder, lying on the under side of the liver, the dark mass to which it is attaehed; *h* is the *coronary* artery, whieh supplies the stomaeh, *a*, *b*, *c*, with blood. The curve of the stomach is well shown. *e e*, the arteries which supply the eaul, marked *i i*, which falls down from the front of the stomach, over the intestines, like an apron; *g*, a vessel of the liver. The *pancreas* is behind the stomach.

ounces of gall, which is carried to it, as a place of deposit, from the liver. A long slender pipe extends from it to the *duodenum*, the first portion of the intestines, into which it pours the bile. The use of the bile is to stimulate the intestines, in order to keep them at work.*

SPLEEN.

Anatomists have not discovered the function of this organ. Generally, however, it is admitted to be essentially serviceable to the stomach. The color is red, somewhat like the liver, broad as the palm of the hand, and one or two inches thick. It is in contact with the stomach, in the left side.

PANCREAS.

Behind the stomach, lying directly across the spine, is the *pancreas*, a narrow gland, from eight to ten inches long, which secretes a fluid analogous to the saliva. Through a duct, it is carried onward, to be mixed with the bile in the intestine. It is regarded as an auxiliary to digestion.

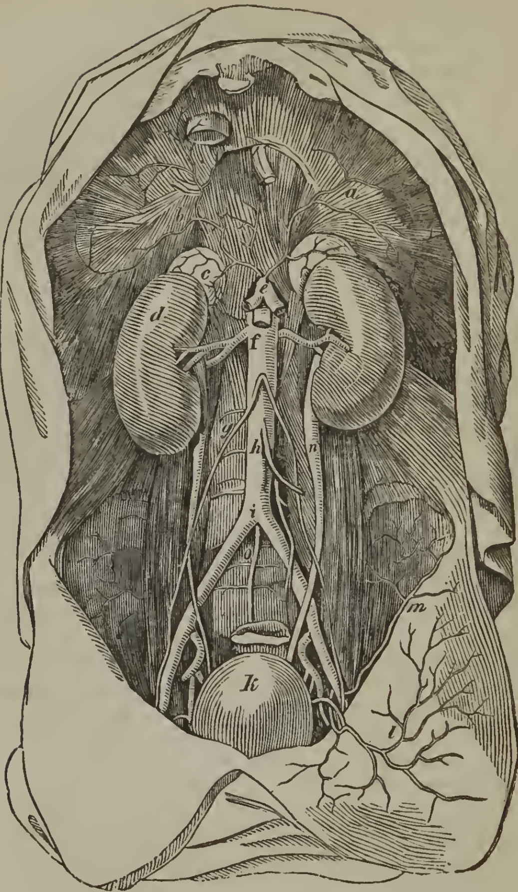
KIDNEYS.

One of these glands is placed on each side, in the loins near the spine, a little above the hips. From the trunk of the aorta, the great artery of the body, two large branches are given off, nearly at right angles, to the kidneys. A quantity of blood is therefore sent directly into them, from which the urine is separated, and afterwards forced through the *ureters*,—two tubes of the size of a writing quill, ten inches or more in length,—into the under and back part of the bladder.

* In all the carnivorous animals, this sac is large. Serpents and fishes, both of which swallow their food whole, require a prodigious quantity of bile. The moment it has entered the stomach, the gall-bladder, in them, particularly, begins to fill, and in the course of two days seems full, almost to bursting. When the mass has dissolved, and becomes converted into chyme, and the intestinal motion is sufficiently strong, then the gall-bladder, being no longer called upon for an extra quantity of stimulating fluid, at once diminishes in size.

Where are its contents carried?
Of what service is the bile?
How many kidneys?
From whence do they secrete their fluid?

Fig. 104.



Explanation of Fig. 104.

In this, *a* and *b* show the tendinous part of the diaphragm or partition between the chest and abdomen: *d*, the kidney, with its fellow opposite; *f*, the *descending aorta; h*, an artery given off for the intestinal tube; *i*, where the great artery divides, to send a branch to each leg; *g*, the ascending great vein, conveying blood to the right side of the heart; *c*, the *capsule*, so called, belonging to the kidney, the use of which is un-

known; *n*, the *ureter*, a tube which conveys the urine from the kidney to the under side of the bladder, where it terminates. The right ureter is seen on that side, also terminating in the bladder, *k*. *m*, *l*, are arteries; *o* is a small artery, which runs down, on the bone, into the pelvis.

The urine is separated from the blood by the extremities of the arteries within the substance of the kidney. Having remained a while in the bladder, it excites a desire to void it,—an action effected chiefly by the muscular fibres of the bladder itself, assisted by the abdominal muscles. It is prevented from retrograding from the bladder to the kidneys, by a valvular structure within, continually closed by the presence of the fluid against the valve.*

STOMACH.

Just below the diaphragm, lying nearly horizontally across the top of the abdomen, is the stomach, having the shape of a shot-pouch,—being large at the extremity on the left side, and small where it reaches the right, under the margin of the liver. It presents a curve in front, and a shorter one on the back side, where it embraces the spine.

At the entrance of the *œsophagus*, the food tube from the mouth, at the large end of the orifice, is called the *cardiac orifice*, because it was supposed by the early anatomists to be near the heart. Through this the food enters the stomach; and where it makes its exit, into the beginning of the intestine, at the other extremity, the opening is the *pyloric orifice*. A muscle surrounds the neck of the stomach, on the inside, which holds a control over the contents, allowing it to pass onward, or confining it within, according to its state of preparation for digestion.

* Anatomists have indulged the opinion for a long time, that there is a more direct communication between the stomach and bladder than has yet been discovered. It seems impossible, say they, that so great a quantity of fluid as may be voided in half an hour, could have been drawn by the kidneys, alone, from the circulating blood. Notwithstanding the offer of a liberal premium to the fortunate discoverer of the mode of action, if any exists, different from what the science of anatomy has already displayed, no one has yet been successful in the research.

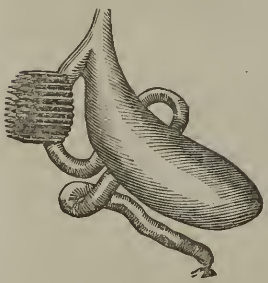
In what part of the abdomen is the stomach placed?
What is its shape?
What name has its lower orifice?
Why does not the food pass onward directly through it, into the intestines?

MECHANISM OF THE STOMACH IN BIRDS AND RUMINANT ANIMALS.

By comparative anatomy, we discover that there are several varieties in the mechanical structure of this only partially understood organ, in the inferior races, adapted to the circumstances of their physical condition.

The membranous stomach is found in all the carnivorous or flesh-eating animals and fishes, very similar in character to our own. If any thing, they secrete, perhaps, a more copious supply of gastric juice in a given time. As this is one of the most powerful antiseptics in nature, putrid aliment loses its rancid odor nearly as soon as it is brought in contact with it. Many animals prefer carrion to freshly-slain meats, because it is more easily digested. Hence dogs, crows, vultures, &c., instinctively select food in a putrid state. Crocodiles not unfrequently drag their prey about under water till the putrefactive process commences. Gourmands, as exhibited in those, for example, who are in the habit of keeping mutton and venison till decomposition begins to take place, before it is considered fit to be cooked, practise upon the same principle. There is less labor imposed upon the teeth, and more consequently devolves upon the stomach inasmuch as the gastric juice corrects its rancidity.

Fig. 105.



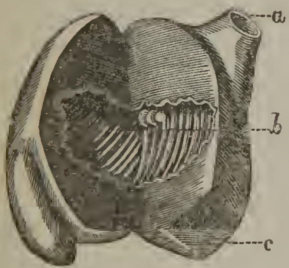
Explanation of Fig. 105.

This is the receiving stomach of a fish called whiting. It will be observed that it belongs to the class of membranous stomachs, and that it is an appendage, as it were, of the intestine, standing out almost at a right angle from the main canal. With a very few exceptions, all the fishes possess this kind of receiving pouch, into which smaller fishes and other food are taken whole. As fast as portions become softened, they go back again through the strait by which the mass was received, but, instead of returning to the mouth, make a short turn down into the intestine. In the first inch or two of this, where chymification is effected, a cluster of fleshy, red spikes are seen. These

are tinged with blood, from which the gastric juice is secreted in great quantities. While digestion is going on, and till the membranous stomach is completely emptied, they remain erectile, but as soon as the whole has disappeared, they become pale and flaccid. If a fish is examined immediately on being caught, these spleens or gastric juice-providing organs will be seen in these several conditions, according to the fulness or diminished volume of the contents of the neighboring stomach. This contrivance, therefore, bears some resemblance to the functions of the membranous stomach or paunch of the ruminants. The intestine is remarkably short in all the fishes, as it is in all carnivorous animals.

Granivorous birds are furnished with a muscular stomach of a peculiar construction. As they are wholly without a dental apparatus for comminuting their food,—a preparatory step of vast importance to animals possessing the membranous stomach,—the gizzard, in effect, is a mill, in which, whatever is taken into the crop, drops down into it at regular intervals, to be pulverized and mixed with the secretions elaborated in it, and finally converted into a soft paste. This, then, as will be readily understood, actually changes the ingesta into the same sort of nutritious matter that is found in the first kind of stomach, only the result is effected by a different machine. The crop is only a receiving organ or hopper, or, in other words, a store-house, which is filled from time to time, as circumstances and the necessities of the bird may require. In the crop, the kernels of corn are moistened, and therefore softened a little,—a favorable preparation, because less muscular force will be required to reduce it to the neces-

Fig. 106.



Explanation of Fig. 106.

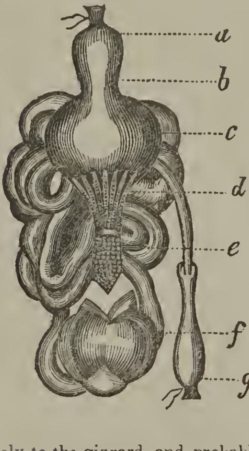
This engraving illustrates the internal structure of the gizzard. *a* is the canal through which the softened food passes into the centre of this powerful muscular machine. *b* shows the deep lines and ridges which cut and divide the mass, in order to expose every part to the action of the organ as it collapses upon the contents within. *c* indicates the division of one of the three thick muscles, spoken of in the text.

The ostrich has commonly been regarded as the most stupid of all the birds, and the least benefited by the organs of sense, because, in a state of captivity, it swallows buttons, nails, watch-keys, glass, &c., indifferently. The poor biped is actually driven to this sad necessity, for want of gravel, which menagerie keepers seem not to think of. All these hard things immediately pass into the gizzard, and there are made use of as teeth to mull and comminute the food.

sary degree of fineness to become chyme. Although the gizzard is embraced by three short, immensely strong muscles, which, acting in concert, diminish the volume of the organ so much as to compress whatever may be within, like a vice, were it not replenished with particles of gravel quite frequently, the bird could not live. These are its teeth; and by the combined action of the external muscular straps, the gastric juice and the trituration of the stony particles, even needles, lancets, and the points of small nails, are made so smooth that the pylorus will admit them to pass into the intestine, which it would not do, were the canal liable to be injured by their progress.

Pigeons have an unusual enlargement of the calibre of the œsophagus, or swallow, where it joins the crop, at the season of rearing their young. This is a most admirable provision, for the food, becoming softened by remaining a short time there, is precisely fitted to the feeble digestive powers of the unfledged young. Both parents unite in

Fig. 107.



Explanation of Fig. 107.

The whole of the digestive apparatus of the pigeon is here delineated. *a* is the enlargement of the œsophagus, into which the young pigeon's head enters, and at *b* the bill passes through a narrowing of the tube, into *c*, the crop, where the food has become considerably softened by the heat of the body and the secretions of the organ, and from which the little bird feeds several times a day. *d* are a congeries of glands, embracing the lower part of the crop, reaching to the gizzard, similar in office to the *spleen* in other animals. It is supposed that they contain blood, from which the gastric fluid is secreted. At *e*, below a circular muscle, a kind of pylorus, are the stomach glands, or little spleens, which appear to be appropriated exclusively to the gizzard, and probably elaborate a more powerful solvent juice. *f* is the gizzard, and *g* the termination of the intestinal canal. The lacteal vessels,—those which convey the chyle into the circulation, are dispersed throughout the entire tract of the intestines. In the above diagram, the gizzard, *f*, is represented as separated from the craw, *c*, to show the manner in which the muscles embrace its lower portion. As a whole, it is regarded by anatomists as a very curious piece of mechanism.

the task of providing for their helpless offspring, by allowing them to pick their daily sustenance directly from their own throats.

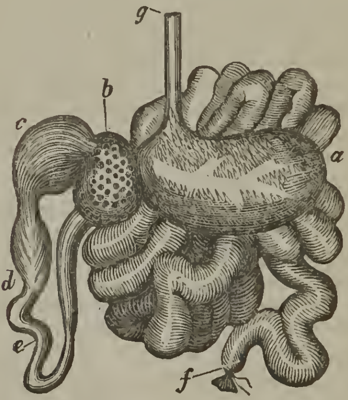
Bony stomachs are found in the worms: lobsters, crabs, and the like class of animals, whose skeletons are thrown outside the flesh, instead of being in the centre of the muscular system, have similarly organized stomachs. They, too, are destitute of teeth in the jaws, though well supplied with them at the internal entrance of the stomach. Whatever is there introduced is instantly subjected to the forcible manducation, or rather kneading operation, of these active auxiliary agents. By a law of their nature, once a year, the shell is necessarily cast off, and a new one is developed within a very few days. At the same time this important change to their physical welfare is going on, the gastric teeth are also shed, and new ones take their places, tipped with enamel, and subject, as the former set were, to the unceasing control of muscles which force them to action.

Nothing, in the estimation of an anatomist, is more admirable than the mechanical contrivance and harmonious operation of the compound stomach of graminivorous animals; such as cows, sheep, deer and several others. These are called ruminants, because they chew the cud. They not only have the membranous sac or receiving organ, as in man and birds, but, superadded, are three others, making four in the whole.

However much may have been swallowed in the course of the day, not a particle is permitted to pass into the second stomach till it has been properly masticated in the mouth. Thus, when a sufficient mass has been collected for future rumination, these social animals quietly lie down. By an act of volition, a mouthful of this crude food instantly runs up the œsophagus, which the tongue presses into the line of the grinders. With them, without doubt, the principal pleasure of eating consists in chewing the cud. When sufficiently mulled in the form of a ball, it is reswallowed into the same place from whence it was raised; but, instead of stopping there, as in the first instance, the orifice leading into the second stomach, at this particular juncture, opens to receive it, and, the moment the portal is passed, the gate closes, before any thing in the neighborhood can possibly gain ingress. The same process is repeated till the whole is regularly inducted to the second

apartment. In this, it is mixed with water and the secretions, and very much softened and diluted,—a preparatory step for its entrance into the third, where it is further changed by the addition of bile, and divided into portions, each of which, on arriving at the fourth sac, of a thin, milky consistence, is there turned into curd, or chyme, very similar in taste and appearance to the dairy curd before being pressed. It is this fourth division of the ruminant stomach which farmers take from calves, under the name of *rennet*, to curdle milk for making cheeses.*

Fig. 103.



Explanation of Fig. 103.

In this engraving, we have endeavored to represent the compound stomach of a sheep. There is not much difference in the arrangement or structure of the compound stomach of ruminant animals, generally, from this, provided they possess horns. If a ruminant, as the rabbit and camel, for example, are destitute of those appendages, they have only one preparatory stomach, performing the functions of the two first, marked *a* and *b* in this plan. The long tube at *g* is the œsophagus, or food-pipe, leading from the top of the throat to the receiving stomach, *a*, from whence the food is raised again in balls to the mouth, and, when re-swallowed,

* Quantities of hair are not unfrequently found in the maws, or first stomach, which cattle swallow by licking each other in the spring, when they are shedding their coats. These are sometimes enormously large, but, not being permitted by the pyloric, constrictor muscles to pass into the next stomach, because they do not give the true countersign,—that is, produce the right kind of sensation, they are retained where they were first received, for years, becoming, by being constantly rolled about, excessively hard, compact balls.

the mouthful passes directly into *b*, through an opening between the two sacs which closes as soon as the morsel enters. This stomach *b* contains the pockets for holding water in the camel: this is the part called *tripe*, and, by farriers, the *king's hood;* and *a*, the first stomach, the *paunch*. From the second stomach *b* the food enters, through a small aperture, into *c*, the *manifolds*, or third stomach, from whence it is forced into *d*, the fourth stomach, also familiarly known as the *rennet:* *e* is the beginning of the duodenum, or first portion of the small intestines, where the bile and other fluids are poured in to dilute the contents and otherwise facilitate digestion. In all these animals there is an amazing length of intestinal tube: it is nearly fifty feet long in the sheep.

In configuration and general arrangement, the stomach of the camel is very analogous, being also a ruminant. Destined, however, to live in those sultry, arid countries where water cannot be found, only at very distant stages; and as they are the servants of man, by which he maintains an intercourse with his fellow man in nomadic life, roaming over vast tracts of scorching deserts of sand, the wonderful mechanism of this patient animal's second stomach enables it to endure exposure to the burning sun, days in succession, where no other being would long survive.

The inner surface of the hood, as it is sometimes called, or second stomach, of the ox, is arranged into small square pits: when prepared by slight maceration, the divisions or walls of these cells, faintly resembling the plan of the partitions in honey-comb, become quite distinct and prominent: this is *tripe*, a familiar culinary dish. The same system of arrangement exists in the camel, only the cells are vastly deeper, and consequently more capacious. Each one of these pockets has a constrictor muscle round its margin, acting independently of all the rest. When the camel, therefore, takes in a sufficient stock of water for a long journey, it is packed away for future use, in the following manner:—As each draught swallowed enters through the doorway from the first stomach, it runs into one of the cells till it becomes sufficiently distended. The circular marginal muscle then closes up the top, much as the mouth of a sac is drawn together by a cord. A second is now filled in the same way; then a third, fourth, and so on, till the whole are completely supplied and well secured. When thus packed, no resistance is offered to the food, which can pass along through a central line as it did before any water was taken in. When the necessities of the system require, one of these bottles opens itself, and pours its contents into the common

receptacle, where it dilutes the food, and from whence the absorbents conduct it through the body, to be exhaled upon the surface as insensible perspiration, and otherwise disposes of it, as the economy of their organization may require. Ordinarily, only one cell empties itself at a time, unless there is a positive necessity for it. The camel, however, has no sort of control over them in regard to this part of the process.

Water, thus stored in the stomach of a camel, will keep perfectly sweet, without undergoing any apparent change, an indefinite period of time.

When all other sources of supply have failed, the Arab, reluctant as he may be to part with a friend, on whose ability to travel over deserted regions the preservation of his life depends, kills the unconscious beast, and slakes his own parching thirst with the reserved fund he may find in these beautifully-arranged aquatic reservoirs.

INTESTINES.

With a little variation, the whole extent of the intestinal tube is six times the length of the body, except in infancy, when it averages eight times the height of the child.

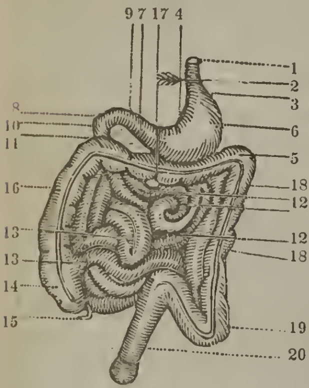
It is divided into *small* and *large* intestines. The small one is further divided into, first, the *duodenum*, only about a foot long, commencing at the stomach;—into this portion the bile and pancreatic juice is delivered: secondly, the *jejunum*, coiled up nearly round the navel: and, thirdly, the *ileon*, the last part of this intestine, joining the *cæcum*, or beginning of the large tract. Usually, the diameter of this tube is not far from one inch.

Secondly, the large intestine is divided into the *cæcum*,—a large, irregular, membranous sac, with a valve that obstructs the return of whatever may have once passed it; the *colon*, about two inches in diameter, lying near the hip, at the bottom of the abdomen, on the left side, but ascending in a broad curve towards the stomach, crosses the spine, and dips down into the right side, describing an arch—hence this particular part is called the *arch of the colon*. Finally, the *rectum* is the last division, a foot long, terminating externally.

How are the intestines divided? Where is that portion called duodenum?

The inside is beset with the sharp folds of the inner membrane, in the form of shelves, exceedingly numerous, which are termed *valvulæ conniventes.** Their express office is to prevent a too rapid exit of the food, in its descent, before all its nutritious substance has been taken by the *lacteals.*

Fig. 109.



Explanation of Fig. 109.

1, The œsophagus, or swallow perforating

2, The left opening of the diaphragm.

3, The cardiac orifice of the stomach.

4, The small curvature of the stomach.

5, The great curvature of the stomach.

6, The fundus of the stomach.

7, The pyloric orifice.

8, The duodenum, divided into three portions.

9, The ascending,

10, The transverse, and

11, The descending, portion.

12, The jejunum, forming three fifths of the small intestines, distinguished from the ilium in being thicker, more vascular, larger, and having more valves.

13, The ilium, forming less than two fifths of the small intestines, and terminating in the cæcum, having two valves at the entrance.

14, The cæcum, the first of the large intestines, situated in the right, having attached to it

15, The appendix vermiformis. The cæcum terminating in

16, The ascending portion of the colon, which directs its course from the cæcum towards the stomach, connected to the right kidney by a fold of the peritonæum.

17, The arch of the colon, traversing the abdomen beneath the stomach.

18, The descending portion of the colon, directing its course towards the left region, connected to the left kidney by a fold of the peritonæum.

19, The sigmoid flexure of the colon, situated in the left iliac region, and terminating in

20, The rectum.

* Within the intestinal tube of the great basking-shark, a monstrous, though inoffensive, inhabitant of the ocean, there is a thin membrane jutting out from the wall of the canal, which winds, apparently, thousands of times around it, precisely like a flight of winding stairs. This large animal, between thirty and forty feet long, feeds exclusively on marine vegetables,—such, principally, as are torn up by the force of storms. Prodigious quantities are taken into the stomach when the fish has an opportunity of gorging it. A full supply is not always at hand, and

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Explain the economy of the valvular apparatus of the intestines?

MESENTERY.

A duplication or fold of the peritonæum, drawn out, as it were, from the spine, like a ruffle, is the mesentery, on the border of which the intestines adhere. By this they are supported, and kept in place.

Nearly in the centre, between where the mesentery attaches itself to the spine and the intestine, are the *mesenteric glands*, through which the chyle passes in its way to the thoracic duct.

DIGESTION.

Perhaps no animal process has more deeply engaged the attention of physiologists than digestion. The following remarks embrace, in a few words, all that is known upon the subject.

Soon after the food has been admitted into the stomach, considerably softened by the saliva of the mouth and throat, the extremely small arteries spread in the lining membrane of the stomach throw out a fluid which is called the *gastric juice*, which, in addition to the muscular action of the stomach, converts the whole mass into a grayish paste. It is rolled forward to the *pylorus*, the place of passage into the intestine, where there is mixed with it the bile from the gall-bladder, and the juice from the *pancreas*, both of which dilute it still more. The muscular fibres of the first portion being strong, it agitates and rolls it about till it assumes the appearance of a thick milky fluid, of the consistence of cream.

This part of the digestive process, in the first portion of the intestine, is termed *chymification*, and the substance itself *chyme*.

By the peristaltic and vermicular action of the intestine,

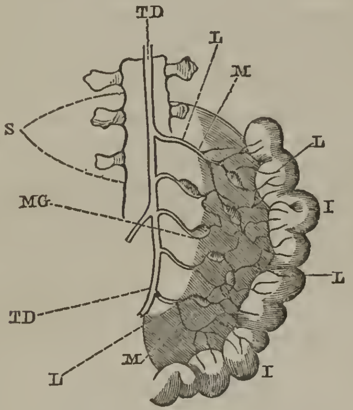
nature, practising invariably upon the strictest rules of economy, introduced this immensely-long screw to prevent the too rapid descent of the food. With this simple mechanical plan, it must, necessarily, in following the spiral, move thousands of feet before any portion is voided. Having been exposed, therefore, to a vast extent of absorbing surface, (the membrane being thickly studded with lacteal vessels,) every particle of nutrition which it is possible to extract from the passing mass is carefully appropriated.

What is attached to the mesentery?
Where are the mesenteric glands?
From whence comes the gastric juice?
What else besides this juice is mixed with the food in the stomach?
What is chymification?
Where is chyle found?

it is carried onward, inch by inch, interrupted by the valves, which throw it from side to side, till every particle is brought into direct contact with the mouths of the *lacteals* everywhere presented. Thus a prodigious extent of absorbent surface is presented to it, through the entire course of nearly thirty feet.

Thus, the further the chyme advances, the more closely and certainly is its valuable part taken up by the countless millions of lacteal vessels. They terminate in the mesenteric glands, where it remains a little time, but for what purpose is not precisely understood, and then, by another set of ducts, the fluid is conveyed into the *thora-*

Fig. 110.



Explanation of Fig. 110.

A portion of the *thoracic duct*, marked T D above, and T D below, lying in front and in contact with the spine S. By the side of I I is seen a portion of intestine attached to the mesentery, a kind of membranous ruffle, around the border of which the entire tube of the intestine is fastened. L L show a lacteal vessel running from the inside of the intestine, charged with a milky fluid which is conducted into the mesenteric glands, seen lying between the two folds of that membrane. In these, the chyle is essentially changed in character, and perhaps receives additional fluid from the gland itself. From these, the fluid next passes on through the excretory ducts M M, which join the main trunk of the thoracic duct.

How is food carried along the tube?
Where are the lacteals?
Have the mesenteric glands any thing to do in changing the character of the chyle that passes through them?

cic duct, to be afterwards carried into a vein in the neck, to be mixed with the blood, and to become blood.

The final cause, therefore, of digestion, is to elaborate a material for making blood, from which the whole system is renewed and sustained. Whatever is useless finally passes onward into the large intestine, which, in effect, is a storehouse, in which its stay is temporary, depending on the health, habit and condition of the individual.

Three hours after the food is masticated, as a general rule, it passes through the various changes which have been described.

Three coats are easily shown in the walls of the stomach and intestines, viz. the *peritoneal*, the *muscular*, and the *mucous*. The muscular is a series of fleshy fibres, fine as sewing-thread, winding round the cylinder; longitudinal fibres are also discoverable; hence there are two particular motions in the intestine. By the contraction of the straight fibres, the intestine is gathered up in wrinkles, at different points, through its whole extent, and then elongated again, much like the movement of a worm; by the contraction of the others, it is diminished in diameter at different sections: thus they are never at rest, but continually moving the chyme from place to place. The first motion is the *vermicular*, and the second the *peristaltic*.

THE FLUIDS.

HYGROLOGY.

A VARIETY of fluids are separated from the blood, by numerous organs, for various purposes, which are divided into *crude*, *sanguineous*, *lymphatic*, *secreted*, and *excrementitious*.

An example of a crude fluid is found in the *chyle;* the

What is the final cause of digestion?
Have the intestines distinct coats? Name them.
How are the circular fibres arranged?
What is the effect of the contraction of the longitudinal fibres?
What is the vermicular motion?
And what the peristaltic?
How are the fluids arranged?
Sanguineous?

sanguineous in the *blood;* the lymphatic in the *lymphatic vessels;* and the *excrementitious* are all such as are expelled from the system as useless.

Again, the secreted fluids are further subdivided into the *lacteal*, as that in the tubes between the intestines and mesenteric glands; *aqueous*, in the eye; *mucous*, in the nose; *albuminous*, as the serum of the blood; *oleous*, as the fat; and *bilious*, as exemplified in the bile.

LYMPHATICS, AND THEIR SECRETIONS.

Wherever a moisture exists, either externally or in the obscure cavities of the body, under the skin, among the muscles, in the brain, and indeed where any motion is effected, the *lymphatics* exist also, though they are invisible. They take up the vapor or fluid and carry it to the *thoracic duct*, to be mixed with the blood. If any nutritious matter is unnecessarily expended in any one of these places, it is sure to be collected again, and returned to the circulation.

Without these vessels always on the alert, fluids would accumulate beyond the necessities of the organs they were designed to assist, which would inevitably abridge the freedom of action, and produce disease.

Thus, whatever is superfluous is sent back to the blood, whence, perhaps, in a majority of cases, it was taken, and, if of no further value, it is thrown into the kidneys, and a large portion of it, therefore, is thus conveyed from the body through the agency of the urinary apparatus.

FLUIDS OF THE CRANIUM.

A vapor exhales in the ventricles of the brain, secreted by the delicate arteries, to prevent an adhesion of the sides, and to keep the contents of the head moist.

OF THE NOSTRILS.

Part of the mucous in these canals consists of the tears passing down the lachrymal duct from the eyes, adverted to in the anatomy of the eye. Besides this, a congeries of muciparous glands under the lining membrane also

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Where are the lacteals found?
The albuminous?
The bilious?
What are lymphatics?
Where do they most abound?

mix their secretions with them to preserve the olfactory nerves from becoming dry, which would destroy their sensibility.

No fluid whatever *distils from the brain into the nose*, as is sometimes vulgarly supposed. These are the only sources, even when in excessive quantity, as when laboring under a severe cold, whence it arises.

OF THE MOUTH.

Under the tip of the tongue, the angle of each jaw, and, lastly, under the ear, between the jaw and neck, are large *glands*, each secreting a fluid of the same character,—the *saliva*, in quantity sufficient to soften the food for mastication, and to keep the tongue, fauces, sides of the mouth and lips, moist and flexible. Such is their activity, that several ounces are ordinarily collected in the course of one meal. Each gland has a duct leading into the mouth. The motion of the jaws in chewing and swallowing contributes to the flowing of the fluid.

THE SKIN.

Above the muscles, and directly under the skin, is a spongy layer, called *cellular substance*, the cells of which are filled with fat. This cellular covering is enormously thick in whales, and denominated the blubber, which keeps the animal warm. Above this is the true skin,—smooth and delicate on its external surface, but of a looser texture on the under side, where it forms a union with the cellular substance. This true skin is *technically* called *cutis vera*. It is profusely supplied with blood-vessels, and so numerous are its nerves, that the point of a needle can nowhere be inserted without wounding one of them.

As all the nerves finally run towards the surface of the body, it has led some to the opinion that the true skin was a tissue of nerves and vessels, so intimately interwoven as to constitute a highly-sensitive envelope for the

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What do you know of the cellular substance? What is the color of the cutis vera?

body. The color of the true skin is nearly the same in all races of men,—being as white in the negro as in the European.

RETA MUCOSUM.

There is spread over the true skin an extremely thin layer of paint, of the consistence of thin size, which has received the name of *reta mucosum*, and on this wholly and entirely depends the color or complexion of the individual. In the negro, this mucous paste is jet black; in the Indian, copper-colored; in the Spaniard, yellowish; but white in the white variety of our species. This pigment is constantly flowing out upon the skin, to defend its irritable surface against the combined influence of the air, light, and heat. These agents, however, exert an action upon the mucous coloring, which dries, becomes hard and insensible, and is continually wearing off, and as constantly renewed.

SCARF-SKIN.

A familiar example of the scarf-skin, the exterior coat of all, is observable in blisters. It is totally insensible, rough, and by no means of a uniform thickness. In the palms of the hands, and soles of the feet, it becomes prodigiously thickened, to defend the tender parts below. This scarf-skin is constantly wearing off, and as constantly renewed, and hence it is inferred that it is really nothing more than the reta mucosum, thrown off by the action of the excretory vessels.

The query may arise, why, if this is the case, are not the palms of the negro's hands perfectly black? They would be so if the scarf-skin in them had not lost its vitality. When the negro has suffered from a severe burn, the mouths of the ducts which poured out the coloring matter, are sealed up by the subsequent inflammation, so that no more paint is thrown out, and the scar remains white. The reason is plain; the true skin, which is white, is no longer obscured by the black pigment.

Rouge, pearl-powder, cream of almonds, milk of roses, cologne, spirit of wine, and, indeed, the endless catalogue

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Where is the reta mucosum secreted? Is the scarf-skin insensible? Its use?

of cosmetics, which are sold in the shops with the ostensible object of beautifying the skin, are abominable impositions, which ought to be interdicted, by a strict police regulation, till the happy period arrives when common sense is more frequently exercised on the subject of personal appearance. The skin cannot be made permanently whiter, nor can the hair be stained without injuring it; a roseate tint cannot be given to the cheek, by any preparation, that will be abiding. All this class of pretended beautifying articles positively injure the skin, leaving it rougher; and, in old age, in consequence of their habitual application, the face is more thickly wrinkled, and the complexion assumes the hard, dead color of bronze. Still worse, the pores are deranged in their functions, and disease may be induced by the absorption of some of the ingredients of those noxious importations, which were never good for any thing but to fill the manufacturer's purse at the expense of those who are willing to be the dupes of their own folly. Cold water is truly a cosmetic, and should be used exclusively.

The physiology of the nails, which are supposed to be a production of the scarf-skin, is not well understood. Writers have not given a satisfactory explanation of their origin or growth.

With respect to the hair, its growth bears a striking analogy to vegetables, inasmuch as it rises from a bulbous root, imbedded in the skin, into which a gelatinous fluid is secreted. It would be entirely unnecessary to detail the opinions of authors on this subject, or to be very particular in relating our own.

From whence do the nails have their origin?

GLOSSARY.

ABDOMEN, (*abdere*, to hide,) the lower venter or belly, containing or hiding the intestines, etc.

ACANTHA, (ἄκανθα, a spine or thorn,) sometimes used for the spine.

ACETABULUM, (*acetum*, vinegar,) the socket for the head of the thigh-bone, resembling an ancient vessel for holding vinegar.

ACINI, (*acinus*, a grape-seed,) the internal structure of several glands.

ACOUSTIC, (ακουω, to hear,) a term applied to parts belonging to the ear, or to sound.

ACROMION, (ακρος, the extremity, and ὤμος, the shoulder,) a process of the scapula.

ADENOLOGY, (αδην, a gland, and λογος, a discourse,) the doctrine of the glands.

ADEPS, fat, an oily matter contained in the cellular tissue.

ADNATA, (*adnascor*, to grow to,) the external coat of the eye.

ADOLESCENCE, the age succeeding childhood.

ALBUGINEA TUNICA, a membrane thus named from its whiteness.

ALBUMEN, an animal substance of the same nature as the white of an egg.

ALVEOLI, (*alveus*, a cavity,) the sockets for the teeth.

AMPHIARTHROSIS, (αμφω, both, and αρθρον, articulation,) an articulation admitting of an obscure motion.

ANASTOMOSIS, (ανα, through, and στομα, a mouth,) the communication of vessels with one another.

Anatomy, (ανα, through, and τεμνω, to cut,) dissection, or that knowledge of animal bodies acquired by dissection.

Ancon, the elbow, (from ἀγκῶν,) because the bones, being there united, are folded one into another. Hence, also,

Anconeus, a muscle situated there, and,

Anconoid, a process of the cubit, from αγκων, the elbow, and ειδος, shape.

Aneurism, an unnatural enlargement of an artery.

Angeiology, (αγγειον, a vessel, and λογος, a discourse,) a description of the vessels.

Antagonist, (αντι, against, and ἀγων, a struggle,) an epithet of a muscle acting contrary to another.

Antihelix, (αντι, against, and ειλω, to turn about,) the external part of the ear opposite to the helix.

Antithenar, (αντι, against, and θεναρ, the palm of the hand,) one of the muscles extending the thumb.

Antitragus, (αντι, against, and τραγος, a part of the ear,) a prominence of the ear opposite to the tragus.

Aorta, (αορτη; from αηρ, air, and τηρεω, to keep,) the great artery of the heart.

Aponeurosis, (απο, from, and νευρον, a nerve,) a tendinous expansion, supposed by the ancients to be that of a nerve.

Apophysis, (αποφυω, to spring from,) the process of a bone, and a part of the same bone. Epiphysis, a process attached to a bone, and not a part of the same bone.

Arachnoides, (αραχνη, a spider's web, and ειδος, likeness,) a cobweb-like membrane, the second covering of the brain.

Arteria, (αηρ, air, and τηρεω, to keep,) because the ancients thought that air was contained in the arteries.

Arthrodia, (αρθρον, a joint,) that kind of articulation which is shallow.

Arytenoides, (αρυταινα, an ewer, and ειδος, shape,) two cartilages of the larynx.

Aspera Arteria, (*asper*, rough, and *arteria*, an air-vessel,) the trachea or wind-pipe.

Astragalus, (αστραγαλος, a die,) a bone of the tarsus: the corresponding bones of some animal were used by the ancients as dice.

Atlas, the first of the cervical vertebræ, so named from supporting the head, as Atlas was supposed to support the world.

Axilla, the arm-pit.

Azygos, (*α*, without, and *ζυγος*, a yoke,) a term applied to any part not having a corresponding part.

Basilica, (*βασιλευς*, a king,) an epithet, by way of eminence, given to one of the veins of the arm, to an artery of the brain, and to a process of the occipital bone.

Bicornus, (*bis*, two, and *cornus*, a horn,) having two horns.

Biceps, (*bis*, twice, and *caput*, a head,) composed of two heads.

Bimanus, (*bis*, two, and *manus*, a hand,) having two hands.

Biped, (*bipedis*, gen. of *bipes; bis*, double, and *pes*, a foot,) having two feet.

Brachium, (*βραχυς*, short,) because, in general, from the shoulder to the hand is shorter than from the hip to the foot.

Bregma, (*βρεχω*, to moisten,) the space between the bones of the infant head through which the superfluous humors of the brain were supposed to pass.

Bronchi, (*βρογχος*, the wind-pipe,) the ramifications of the trachea.

Buccinator, (*buccina*, a trumpet,) a muscle of the cheek, much used by trumpeters.

Bursalogy, (*βυρσα*, a purse, and *λογος*, a discourse,) a description of the bursæ mucosæ.

Cacochymy, (*kakos*, bad, and *chumos*, juice,) an unhealthy state of the animal secretions, or juices.

Cadaverous, (*cadaver*, a dead body, from *cado*, to fall,) looking like a corpse.

Cæcum, blind: a term applied in anatomy to an impervious canal, or to a part which terminates abruptly in a pouch.

Calcaneum, (*calx*, the heel,) the name of the os calcis.

Calcareous, of the nature of lime.

Calidity, (*calidus*, hot,) heat.

Callous, (*callus*, hardness,) insensible.

CALVARIA, or CALVA, (*calvus*, bald,) the upper part of the cranium, which turns first bald.

CANCELLI, (lattice-work,) the spongy substance in bones.

CANINE, (*canis*, a dog,) in relation to the teeth, resembling the dog's.

CAPILLARY VESSELS, (*capillus*, a hair,) the small ramifications of the arteries and veins.

CAPSULE, a membranous production inclosing a part like a bag.

CARDIA, (καρδια, the heart,) the superior opening of the stomach, so called from being situated near the heart.

CARNIVORA, (*caro*, flesh, and *voro*, to devour,) animals that live on flesh.

CAROTID, (καροω, to induce sleep,) arteries of the head and neck, which if tied, the animal becomes comatose, or has the appearance of being asleep.

CARPUS, (καρπος,) the wrist.

CARTILAGE, gristle, a matter softer than bone, but harder than ligament.

CARUNCULA. This word is a diminutive from *caro*, flesh.

CATARRH, (*katarrheo*, to flow from,) a disease.

CATHARTIC, (*kathairo*, to purge,) purgative drugs.

CATOPTRICS, (*katoptron*, a looking-glass, *kata*, against, and *optomai*, to see,) that part of the science of optics which relates to vision by reflection.

CAUDAL, (*cauda*, a tail,) applied to the lower part of the spine.

CELLULA, (diminutive of *cella*, a cell,) a little cavity or cell.

CEPHALIC VEIN, (κεφαλη, the head,) the ancients being accustomed to open this vein in disorders of the head.

CERATOGLOSSUS, (κερας, a horn, and γλωσσα, a tongue,) a muscle running from one of the cornua of the os hyoides to the tongue.

CEREBELLUM, dim. of CEREBRUM, the brain, (καρη, the head,) little brain.

CERUMEN, (*cera*, wax,) a secretion within the ear.

CERVIX, the hinder part of the neck, the fore part being called COLLUM.

CHOLEDOCHUS DUCTUS, (χολη, bile, and δεχομαι, to receive,) the common bile-duct.

CHORDA, (χορδη, a cord or assemblage of fibres,) a term applied to a nerve of the tympanum, to the spermatic vessels, etc.

CHOROIDES, so called on account of its many blood-vessels resembling the chorion.

CHRONIC, (*chronos*, time,) a long-standing disease.

CHYLE, (χυλος, the juice,) the milk-like fluid in the lacteal vessels.

CLAVICULA, (dim. of *clavis*, a key,) the clavicle or collar-bone, so called from its resemblance to an ancient key.

CLINOID, (κλινη, a bed, and ειδος, shape,) processes of the sella turcica of the sphenoid bone, so called from their resemblance to a couch.

COCCYX, (κοκκυξ, a cuckoo,) the lower end of the spine, so called from its resemblance to the beak of that bird.

COCHLEA, (κοχλος, a conch,) a cavity of the ear resembling the shell of a snail.

CŒCUM, the blind intestine.

CŒLIACA, (κοιλια, the belly,) the name of an artery in the abdomen.

COLON, (κωλον,) the first portion of the large intestine.

COMMISSURA, (*committo*, to join together,) applied to parts which unite the hemispheres of the brain.

CONCHA, (κογχη, a shell,) applied to the hollow of the ear, from its resmblance to a shell.

CONDYLE, (κονδυλος, a joint, a knuckle, a knot,) an eminence in several of the joints.

CONGLOBATE, (*conglobatus*, gathered together in a circle,) a gland subsisting by itself, like those of the absorbent system.

CONGLOMERATE, (*conglomeratus*, heaped together,) a gland composed of various glands.

CORACO. Names compounded with this word belong to muscles which are attached to the coracoid process of the scapula.

CORACOID, (κοραξ, a crow, and ειδος, resemblance,) like the beak of a crow.

CORNEA, (*cornu*, a horn,) the anterior transparent convex part of the eye.

CORNU, (a horn,) applied to a process resembling a horn.

CORONARY, (*corona*, a crown,) vessels so called from surrounding the parts like a crown.

CORONOID, (κορωνη, a crown, and ειδος, shape,) a process shaped like a crown.

CORPUS CALLOSUM, (*corpus*, a body, and *callus*, hard,) part

of the medullary substance of the brain, supposed to be firmer than the rest.

CORTICALIS SUBSTANTIA, (*cortex*, bark,) the exterior or cortical substance of the brain.

COSTÆ, (*custodio*, to guard,) the ribs, because they guard the heart, etc.

COTYLOID, (*κοτυλη*, an old measure, and *ειδος*, shape,) the cavity for receiving the head of the thigh-bone, resembling the rotuli.

COXÆ, the haunches.

CRANIUM, (*κρανιον*, the skull, quasi, *καρανιον*, from *καρα*,) the head.

CRIBRIFORM, (*cribrum*, a sieve,) perforated like a sieve.

CRICOID, (*κρικος*, a ring, and *ειδος*, shape,) the annular cartilage of the larynx.

CRISTA GALLI, a portion of the ethmoid bone, so called from its resemblance to a cock's comb. *Crista*, a term applied to other parts which resemble a crest.

CRURA, (*crus*, a leg,) applied to some parts from their resemblance or analogy to a leg.

CRYPTS, (*κρυπτω*, to hide,) mucous follicles which are concealed.

CRYSTAL, (*krustallos*, ice,) one of the humors of the eye.

CRYSTALLINE, (*κρυσταλλος*,) a term applied to the lens, from its resemblance to ice.

CUBITUS, (*a cubando*,) that part of the arm from the elbow to the wrist, because the ancients, during meals, used to recline upon it.

CUBOIDES, (*κυβος*, a cube, and *ειδος*, shape,) a bone of the foot resembling a cube.

CUCULLARIS, (*cucullus*, a cowl or hood,) a broad muscle of the scapula, so called from its shape.

CUNEIFORM, (*cuneus*, a wedge,) wedge-shaped.

CUTICULA, (the dim. of *cutis*, the skin), the scarf-skin.

CUTIS, the skin.

CYSTICUS DUCTUS, (*κυστις*, a bladder, *ductus*, a duct,) the duct leading from the gall-bladder.

DELTOID, (*Δελτα*, the fourth letter of the Greek alphabet, and *ειδος*, shape,) resembling the Greek letter *Δ*.

DERMIS, (*δερμα*,) the more solid skin.

DETRUSOR URINÆ, (*detrudere*,) to thrust or squeeze out of.

DIAPHRAGM, (*διαφρασσω*, a partition,) the transverse muscle which separates the thorax from the abdomen.

DIASTOLE, (διαστελλω, to relax,) the dilation of the heart, auricles, and arteries, opposed to SYSTOLE, the contraction of the same parts.

DIARTHROSIS, (διαρθροω, to articulate,) a movable connexion of bones.

DIGASTRIC, (δις, twice, and γαστηρ, a belly,) having two bellies.

DIOPTRIC, (*dia*, through, and *optomai*, to view,) assisting the sight in viewing distant objects.

DIPLOE, (διπλοος, double,) the spongy substance between the two tables of the skull.

DISSECT, (*dis*, asunder, and *seco*, to cut,) to cut in pieces.

DORSAL, (*dorsum*, the back,) pertaining to the back.

DUODENUM, (*duodenus*, consisting of twelve, viz. fingers' breadth,) the first portion of the small intestine, so called from its general length.

DURA MATER, (*durus*, hard, and *mater*, a mother,) the outermost membrane of the brain, the ancients finding it harder than, and supposing it to give origin to, the other membranes of the body.

ELAINE, (ελαιον, oil,) the more fluid part of one of the proximate principles of fat.

EMULGENTS, (*emulgeo*, to milk out,) the arteries and veins of the kidneys, so called because, according to the ancients, they strained, and, as it were, milked the serum through the kidneys.

EMUNCTORES, (*emungo*, to wipe away,) glands which, according to the ancients, received the excrementitious matter from the noble parts, as the parotids from the brain, the axillary glands from the heart, and inguinal glands from the liver.

ENARTHROSIS, (εν, in, and αρθρον, a joint,) an articulation of bones, the same as *arthrosis*.

ENCEPHALON, (εν, in, and κεφαλη, the head,) the brain.

ENTERIC, (εντερον, an intestine,) belonging to the intestines.

EPICRANIUM, (επι, and κρανιον,) the integuments and aponeurotic expansion which are extended over the cranium.

EPIDERMIS, (επι, upon, and δερμα, the skin,) the cuticle.

EPIGASTRIC, (επι, upon, and γαστηρ, the stomach,) the superior part of the abdomen.

EPIGLOTTIS, (επι, upon, and γλωττις, *lingula*,) one of the five cartilages of the larynx, situated above the glottis.

EPHIPPIUM, (επι, upon, and ιππος, a horse,) part of the os sphenoides, so called from its resemblance to a saddle.

EPIPHYSIS, (επι, upon, and φυω, to grow,) see APOPHYSIS.

EPIPLOON, (επι, upon, and πλεω, to sail,) the omentum, or that serous membrane of the abdomen which covers the intestines, and hangs from the bottom of the stomach.

ETHMOID, (ηθμος, a sieve,) so called because it is perforated like a sieve.

FALCIFORM, (*falx*, a scythe,) shaped like a scythe.

FASCIA, (*fascia*, a band,) a membranous expansion of certain muscles like a sheath.

FASCICULUS, a little bundle, diminutive of *fascis*, a bundle.

FAUCES, (the plural of *faux*,) the top of the throat.

FIBRIN, a peculiar organic compound, which is the most abundant constituent of the soft solids of animals.

FIBULA, (a clasp,) the lesser bone of the leg, which is thus named from being placed opposite to the part where the knee-buckle or clasp was formerly used.

FIMBRIA, a fringe, a term applied to parts of a fringe-like appearance.

FOLLICLE, (*follis*, a bag,) very minute secreting cavities.

FRÆNUM, (a bridle,) the membranous ligament under the tongue.

GALACTOPHOROUS, (γαλα, milk, and φερω, to carry,) conveying the milk.

GANGLION, (γαγγλιον,) an enlargement in the course of a nerve.

GASTRIC, (γαστηρ, the stomach,) appertaining to the stomach.

GASTROCNEMIUS, (γαστηρ, the belly, and κνημη, the leg,) the muscle forming the thick of the leg.

GASTRO-EPIPLOIC, (γαστηρ, the stomach, and επιπλοον, the caul,) belonging to the stomach and omentum.

GELATINE, (*gelu*,) jelly.

GENIO, (γενειον, the chin;) names compounded with this word belong to muscles attached to the chin.

Ginglymus, (γιγγλυμος, a hinge,) articulation admitting flexion and extension.
Glandula, (dim. of *glans*,) a nut or acorn.
Glenoid, (γληνη, a cavity,) a part having a shallow cavity.
Gliadine, (γλια, glue,) one of the constituents of gluten.
Glomer, a convoluted bundle of glands.
Glosso, (γλωσσα, the tongue;) names compounded with this word are applied to muscles attached to the tongue.
Glottis, (γλωττις, *lingula*,) the superior opening of the larynx.
Gluteus, (γλουτος, the buttock,) muscles forming part of the buttocks.
Gomphosis, (γομφοω, to drive in a nail,) an articulation of bones, like a nail in a piece of wood.

Hæmorrhoidal, (αιμα, blood, and ῥεω, to flow,) a term applied to the vessels of the rectum, because they often bleed.
Harmonia, (ἁρμονια, a close joining,) a species of immovable articulation.
Helix, (ειλω, to turn about,) the outer bar or margin of the external ear.
Hepatic, (ηπαρ, the liver,) applied to parts belonging to the liver.
Hyaloid, (υαλος, glass,) the capsule of the vitreous humor of the eye.
Hyo; names compounded with this word belong to muscles which are attached to the
Hyoides, Os, (υ, and ειδος, shape,) a bone of the tongue resembling the Greek upsilon, υ.
Hypochondrium, (υπο, under, and χονδρος, a cartilage,) the upper region of the abdomen, under the cartilages of the ribs.
Hypogastric, (υπο, under, and γαστηρ, the belly,) the lower region of the fore part of the abdomen.
Hypoglossus, (υπο, under, and γλωσσα, the tongue,) parts which lie under the tongue.
Hypothenar, (υπο, under, and θεναρ, the palm of the hand,) one of the muscles contracting the thumb.

Ileum, (ειλεο, to turn,) a portion of the small intestine, so called from being found convoluted.
Incisores, (*incidere*, to cut,) the fore teeth.

Incus, (an anvil,) a small bone of the internal ear, with which the malleus is articulated.
Index, (*indico*, to point out,) the fore finger.
Infundibulum, (a funnel,) a tube leading from the brain to the pituitary gland.
Innominatum, parts which have no proper name.
Interfemineum; *vide* Perinæum.
Interosseous, (*inter* and *os*,) a term applied to parts situated between bones.
Iris, (the rainbow,) the membrane round the pupil of the eye, deriving its name from its various colors.
Ischium, (ισχω, to support,) that part of the os innominatum upon which we sit.

Jejunum, (empty,) a portion of the small intestine, so called from being generally found empty.
Jugale, Os, the zygoma.
Jugular, (*jugulum*, the throat,) large veins of the neck.

Lachrymal, (*lachryma*, a tear,) belonging to the tears.
Lacteal, (*lac*, milk,) the name of the vessels in the intestines which carry the chyle, a milky-colored fluid.
Lacunæ, little cavities.
Lambdoidal, resembling the Greek lambda, *Λ*.
Lamella, dim. of
Lamina, a scale or plate. It is used for the foliated structure of bones or other organs.
Larynx, (λαρυγξ,) the superior part of the trachea.
Levator, (*levo*, to lift,) applied to several muscles.
Ligament, (*ligo*, to bind,) parts which bind bones, &c., together.
Linea Alba, a white line formed by the meeting of the tendons of the abdominal muscles.
Lumbricales, (*lumbricus*, an earth-worm,) four muscles of the hand and foot.
Lympheduct, (*lympha*, lymph, and *ductus*, a guidance, from *duco*, to lead,) a vessel carrying lymph, a colorless fluid.

Mammalia, (*mazos*, the breast,) those animals which nourish their young with milk.
Masseter, (μασσαομαι, to chew,) a muscle which assists in chewing.

MASTOID, (μαστος, a breast,) shaped like a nipple or breast.
MAXILLA, the jaw.
MEDIANA VENA, the middle vein of the arm, between the basilic and cephalic.
MEDIASTINUM, (*medium*, the middle,) a middle portion separating parts from each other.
MEDULLA SPINALIS, the spinal marrow or cord.
MEMBRANA NICTITANS, (*nicto*, to wink,) a membrane with which birds can occasionally cover the eye.
MEMBRANE, (*membrana*, a film,) a delicate web.
MENINGES, (μηνιγξ, a membrane,) membranes which inclose the brain.
MESENTERY, (μεσος, the middle, and εντερον, the intestine,) the membrane in the middle of the intestines, by which they are attached to the spine.
MESERAIC, (μεσος, the middle, and αραια, the small intestine,) the same as the last article.
MESOCOLON, (μεσος, the middle, κωλον, the colon,) that part of the mesentery in the middle of the colon.
METACARPUS, (μετα, after, and καρπος, the wrist,) that part of the hand between the carpus and fingers.
METATARSUS, (μετα, after, and ταρσος, the tarsus,) that part of the foot between the tarsus and toes.
MITRALIS VALVULA, (*mitra*, a mitre,) valves at the left ventricle of the heart, like a mitre.
MOLAR TEETH, the double or grinding teeth.
MUCUS, (μυξα, the mucus of the nostrils,) a transparent, saline, glutinous fluid.
MYLO, (μυλη, a grinder tooth;) names compounded of this word belong to muscles that are attached near the grinders.
MYOIDES PLATYSMA, a muscular expansion on the neck. See PLATYSMA.
MYOLOGY, (μυς and λογος,) the doctrine of the muscles.

NAVICULARE, (*navicula*, a small boat,) a bone of the carpus, and also of the tarsus.
NEURILEMMA, (νευρον, a nerve, and λεμμα, a coat,) the sheath of a nerve.
NEUROLOGY, (νευρον, a nerve,) the doctrine of the nerves.

OCELLATED, (*oculus*, an eye,) resembling an eye.
ODONTOIDES, (οδους, a tooth, and ειδος, shape,) tooth-like.

Œsophagus, (*οιω*, to carry, and *φαγω*, to eat,) the canal leading from the pharynx to the stomach, carrying what is swallowed into the stomach.

Olecranon, (*ωλενη*, the cubit, *κρανον*, the head,) the elbow. or head of the ulna.

Olfactory, (*olfacio*, to smell to,) having the sense of smell.

Omentum, (*omen*, a guess,) the caul, so called because the ancient priests prophesied from an inspection of this viscus.

Omo, (*ωμος*, the shoulder;) names compounded with this word belong to muscles which are attached to the scapula.

Omo-Plata, (*ωμος*, the shoulder, and *πλατυς*, broad,) the scapula, or shoulder-blade.

Opaque, (*opaco*, to shade,) not transparent.

Ophthalmia, (*ophthalmos*, an eye,) a disease of the eyes.

Ophthalmic, (*οφθαλμος*, an eye,) relating to the eye.

Orbicular, (*orbis*, round,) circular.

Organ, (*οργανον*,) a part which has a determined office in the animal economy.

Osmazome, (*οσμη*, flavor, and *ζωμος*, broth,) a peculiar principle obtained from muscular fibre, having the taste and smell of broth.

Ossify, (*os*, a bone, and *fio*, to become,) to change to bone.

Osteology, (*οστεον*, bone, and *λογος*, a discourse,) the doctrine of the bones.

Oviparous, (*ovum*, an egg, and *pario*, to bring forth,) bringing forth eggs.

Palpi, (*palpo*, to grope or feel one's way,) feelers.

Pampiniformis, (*pampinus*, a vine-tendril, and *forma*, shape.) The spermatic vessels form a plexus, which, from its similitude to the tendrils of a vine, is called pampiniformis.

Pancreas, (*παν*, all, and *κρεας*, flesh,) a gland of the abdomen.

Panniculus Carnosus, (*pannus*, a covering, and *caro*, flesh,) a fleshy covering.

Papillary, (*papilla*, a nipple,) having a resemblance to nipples.

Paralysis, (*paralusis*, through, and *luo*, to untie,) a palsy.

Parenchyma, (*παρεγχεω*, to pour through,) a substance connecting the vessels, etc., of the lungs, liver, etc.

PARIETALIA, (*paries*, a wall,) bones of the cranium, serving as a wall to the brain.

PARIETES. Used to express inclosures which contain organs.

PAROTID, (παρα, near, and ωτος, the gen. of ους, the ear,) a gland situated near the ear.

PATELLA, (dim. of *patina*, a pan,) the kneepan.

PATHETICÆ, (παθος, passion,) the fourth pair of nerves, because by means of these the eyes express certain passions.

PATHOLOGY (*pathos*, disease, and *logos*, a description) treats of diseases.

PELVIS, (πελυξ, a basin,) the basin of the kidneys, or the lower part of the abdomen, in which the bladder and rectum are contained.

PERICARDIUM, (περι, around, and καρδια, the heart,) the membrane surrounding the heart.

PERICHONDRIUM, (περι and χονδρος,) synovial membrane covering cartilage.

PERICRANIUM, (περι, around, and κρανιον, the cranium,) the membrane covering the bones of the cranium.

PERINÆUM, (περιναιον, to flow round, because that part is generally moist.)

PERIOSTEUM, (περι, around, and οστεον, a bone,) the membrane surrounding the bones.

PERISTALTIC, (περιστελλω, to contract,) the motion of the intestines.

PERITONÆUM, (περιτενω, to extend round,) the membrane lining the abdomen and covering its organs.

PERONE, (περονη,) the fibula or small bone of the leg.

PETROSUM, OS, (πετρα, a rock,) part of the temporal bone.

PHALANX, (an army;) the bones of the fingers and toes are called phalanges, from their regularity.

PHARYNX, (φαρυγξ,) a membranous bag at the back end of the mouth, leading to the stomach.

PHLEBOTOMY, (*phleps*, a vein, and *temno*, to cut,) opening a vein for bleeding.

PHRENIC, (φρενες, the diaphragm, φρην, the mind, because the diaphragm was supposed to be the seat of the mind,) the name of a nerve, etc.

PHRENOLOGY, (*phren*, the mind, and *logos*, a discourse,) a science treating of the mind by an inspection of the human skull.

Physiology, (φυσις, nature,) that science which has for its object a knowledge of the actions and functions of the living body.

Pia Mater, the innermost membrane around the brain.

Picromel, (πικρος, bitter, and μελι, honey,) the characteristic principle of bile.

Pisiform, (pea-like,) a term applied to the fourth bone of the first row of the carpus.

Pituitary, (producing phlegm,) a term applied to the membrane of the nose, etc.

Placenta, (πλαξ, a cake.)

Plantaris, (*planta*, the sole,) parts situated in the sole.

Platysma-Myoides, (πλατυς, broad, μυς, a muscle, and ειδος, shape,) a muscle of the neck.

Pleura, (πλευρα, the side,) a serous membrane lining the cavity of the thorax.

Plexus, (*plecto*, to weave together,) a kind of net-work of blood-vessels or nerves.

Pneumonic, (πνευμων, the lung,) appertaining to the lungs.

Popliteus, (*poples*, the ham,) a muscle of the leg.

Post Mortem, after death.

Processus, (*procedo*, to start out,) an eminence of bone.

Psoas, (ψοαι, the loins,) a muscle so named from its situation.

Pterygoid, (πτερα, a wing,) a process resembling a wing.

Pterygo-Staphylini, (πτερυξ, a wing, and σταφυλη, a grape,) muscles arising from the pterygoid process of the os sphenoides, and inserted into the uvula.

Pulmonary, (*pulmo*, the lungs,) relating to the lungs.

Pulsation, (*pello*, to strike,) the perceptible action of the blood in the arteries.

Punctum Vitæ, point of life.

Pupilla, (a little puppet,) the round aperture in the iris of the eye.

Pylorus, (πυλωρος, the keeper of a gate,) the lower orifice of the stomach, guarding the entrance of the bowels.

Pyramidalis, a muscle having the form of a pyramid.

Pyriform, (*pyrus*,) a muscle having the form of a pear.

Quadrumanous, (*quatuor*, four, and *manus*, a hand,) having four hands, as monkeys.

Quadruped, (*quatuor*, four, and *pes*, a foot,) having four feet.

RACHIDIAN, (ῥαχις, the spine,) appertaining to the spine.
RADIUS, (the spoke of a wheel,) the small bone of the fore-arm.
RAMOUS, (*ramus*, a branch,) branchy.
RANULAR, like a frog or toad.
RAPHE, (ῥαπτω, to sew,) a line having the appearance of a seam.
RECTUM, the straight gut, the last of the intestines.
REGION, (*rego*, to rule,) parts of the body.
REGURGITATE, (*re*, back, and *gurges*, a whirlpool,) to flow back.
RENAL, appertaining to the kidney, from
RENES, the kidneys, through which the urine flows.
RETINA, (*rete*, a net,) the net-like expansion of the optic nerve on the inner surface of the eye.
RHOMBOIDEUS, a muscle so called from resembling a geometrical figure, (ῥομβος,) the sides of which are equal, but not right-angled.
ROTULA, (dim. of *rota*, a wheel,) the kneepan.
RUMINATE, (*rumino*, to chew over again,) to chew the cud.

SACRUM, (sacred,) a bone so called because it was offered in sacrifice; lower end of the spinal column.
SAGITTALIS, (*sagitta*, an arrow,) a suture in the cranium.
SALIVA, the fluid secreted in the mouth.
SALVATELLA, (*salvo*, to preserve,) a vein of the foot, the opening of which was said to preserve health and cure melancholy.
SANGUIS, the blood.
SAPHENA, (σαφης, manifest,) the most obvious vein of the leg.
SARTORIUS, (*sartor*, a tailor,) the muscle by means of which the tailor lays his legs across.
SCALENI, (σκαληνος, a geometrical figure with three unequal sides,) muscles of the neck.
SCAPHA, (σκαφη, a little boat,) the depression of the outer ear before the anti-helix.
SCAPHOIDES, (resembling a boat,) a bone of the carpus, and also of the tarsus.
SCAPULA, the shoulder-blade.
SCLEROTIC, (σκληρος, hard,) the outermost or hardest membrane of the eye.
SCUTIFORM, shaped like a shield.
SEBACEOUS, suety; a term applied to glands which secrete an unctuous matter.

Sella Turcica, Sella Equina, Sella Sphenoides, are various names for a part of the sphenoid bone resembling a Turkish saddle.

Septum Cordis, (*sepes*, a hedge,) the fleshy substance which separates the right from the left ventricle of the heart.

Serum, one of the constituents of the blood.

Serous, (*serum*, whey,) thin, watery.

Sesamoid, (σησαμη, an Indian bean,) small bones in the hands and feet resembling the *semen sesami*.

Sigmoid, resembling the Greek ς, sigma.

Simia, (*simos*, flat-nosed,) monkey tribes.

Skeleton, (σκελλω, to dry,) the articulated dry bones of an animal.

Soleus, (*solea*, sole,) a muscle of the leg having the form of that fish.

Sphenoid, (σφην, a wedge,) shaped like a wedge.

Sphincter, (σφιγγω, to constrict,) the name of several muscles, the office of which is to close the apertures around which they are placed.

Spine, (*spina*, a thorn,) the back bone.

Spiracle, (*spiro*, to breathe,) a breathing-hole.

Splanchnology, (σπλαγχνον, the viscera,) the description of the internal organs.

Splenius, (σπλην, the spleen,) a muscle so named from its resemblance to that organ.

Squamous, (*squama*, a scale,) covering as the scales of fishes do each other.

Stapes, (a stirrup,) one of the small bones of the internal ear.

Stearine, (στεαρ, fat,) the more solid part of one of the proximate principles of fat.

Stomachus, (στομα, a mouth, and χεω, to pour,) the stomach.

Styloid, (*stylus*, a pencil,) a process like a pencil on the temporal and other bones.

Succenturiatus, (*succenturiare*,) to supply the place of another.

Suture, (*sutura*, a seam,) an appearance which is most obvious in that union of the bones of the skull constituting the dove-tail suture.

Symphysis, (συμφυω, to grow together,) the connexion of bones which have no manifest motion.

SYNARTHROSIS, (συν, with, and αρθρον, a joint,) articulation without manifest motion.

SYNCHONDROSIS, (συν, with, and χονδρος, a cartilage,) articulation by means of intervening cartilage.

SYNDESMOLOGY, (συνδεσμος, a ligament,) the doctrine of ligaments.

SYNDESMOSIS, the connexion of bones by ligaments.

SYNEUROSIS, (συν, with, and νευρον, a nerve,) the connexion of bones by tendon, formerly mistaken for nerve.

SYNTHESIS, (συντιθημι, to put together,) the anatomical connexion of the bones of the skeleton.

SYSSARCOSIS, (συν, with, and σαρξ, flesh,) the connexion of bones by muscle.

SYSTOLE, (συστελλω, to contract.) See DIASTOLE.

TALUS, (a die,) a bone of the tarsus.

TARSUS, the space between the bones of the leg and the metatarsus.

TEGUMENT, (*tego*, to cover,) any membrane.

TEMPORAL. Bones, etc., have been so named on account of occupying the region of the head on which the hair generally first begins to turn gray, thus indicating the age.

TENDON, (τεινω, to extend,) a fibrous cord at the extremity of a muscle.

TENTACULA, (*tento*, to seize,) organs by which certain animals attach themselves to surrounding objects.

TERES, (round,) the name of a muscle.

TESTACEOUS, (*testa*, a shell-fish,) having a shell.

TETANUS, (*teino*, to stretch,) cramp, rigidity of the muscles.

THALAMUS, (θαλαμος, a bed,) applied to a part of the brain from which the optic nerve takes its origin.

THECA, (a sheath.) The spinal canal is often called theca vertebralis.

THENAR, (the palm of the hand,) a muscle extending the thumb.

THERAPEUTIC, (*therapeuo*, to heal,) teaching the cure of diseases.

THORAX, (θοραξ, the chest,) or that part of the body which contains the heart and lungs.

THYMUS, (θυμος, a bulbous root,) a temporary gland in the thorax.

THYREO. Names compounded with this word belong to muscles which are attached to the

THYROID, (*θυρεος*, a shield,) a cartilage of the larynx compared to a shield.

TIBIA, (a pipe or flute,) the great bone of the leg.

TONSILS, the round glands placed between the arches of the palate.

TRACHEA, (*τραχυς*, rough,) the windpipe.

TRAGUS, (a goat,) a small eminence of the external ear, upon which hair often grows, like the beard of a goat.

TRAJECT, (*trans*, across, and *jacio*, to throw,) the quick rush, for example, of the blood from a wounded vessel.

TRAPEZOID, like a trapezium.

TREPAN, (*trepo*, to turn,) an instrument for cutting out a round piece of bone from the skull.

TROCHANTER, (*τροχαω*, to run or to roll,) a process of the thigh bone, the muscles inserted into which greatly contribute to the action of running.

TROCHLEA, (*τροχαλια*, a pulley,) a kind of cartilaginous pulley.

TROCHLEARIS, an articulation where one part moves round another like a pulley.

TYMPANUM, the drum of the ear.

TYPHUS, (*tuphos*, stupor,) a species of fever.

ULNA, (*ωλενη*, the cubit,) one of the bones of the fore-arm.

UMBILICUS, (*ομφαλος*,) the navel.

URACHUS, (*ουρον*, urine, and *χεω*, to pour,) a ligament of the bladder.

URETER, (*ουρον*, urine,) the canal that transmits the urine from the kidney into the bladder.

URETHRA, (*ουρηθρα*,) the canal through which urine passes from the bladder.

UVEA, (*uva*, a grape,) the posterior lamina of the iris.

UVULA, the pendulous body which hangs down from the middle of the soft palate.

VALVES, (*valvæ*, folding-doors,) little membranes preventing the return of the fluids in the blood-vessels and absorbents.

VASCULAR, (*vas*, a vessel,) consisting of little vessels.

VENESECTION, (*vena*, a vein, and *sectus*, part. of *seco*, to cut,) the act of opening a vein; bleeding.

VENTRAL, (*venter*, the belly,) belonging to the abdomen.

VENTRICLE, (*venter*, the stomach,) applied, in anatomy, to the cavities of the brain and heart.

VENTRILOQUIST, (*venter*, the belly, and *loquor*, to speak,) one who articulates words, and imitates voices, without apparently using the common organs of speech; so called because it was once supposed that the voice came from the lower part of the body, below the vocal apparatus.

VERMICULAR, (*vermis*, a worm,) motion like the movement of a worm.

VERTEBRÆ, (*verto*, to turn,) the bones of the spine.

VERTEBRALIA, (*verto*, to turn,) animals having a spine.

VESICLE, (*vesica*, bladder,) a small bladder-like cavity.

VIS VITÆ, living power.

VIVIPAROUS, (*vivus*, alive, and *pario*, to bring forth,) opposed to oviparous.

VOMER, (a ploughshare,) a bone of the nose.

VOX RAUCA, the changing of the voice from boyhood to manhood.

XIPHOID, (ξιφος, a sword,) like a sword; a term applied to the cartilage of the sternum.

ZOOGONIA, (*zoos*, living, and *gone*, offspring,) the production of living creatures.

ZOOTOMY, (*zoos*, living, and *temno*, to cut,) dissection of the bodies of animals.

ZYGOMA, (ζυγος, a yoke,) the arch formed by the zygomatic processes of the temporal and cheek bones

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